OAK RIDGE NATIONAL LABORATORY
operated by
UNION CARBIDE CORPORATION
NUCLEAR DIVISION
for the
U.S. ATOMIC ENERGY COMMISSION

ORNL-TM-1714

A SURVEY OF UNDERGROUND UTILITY TUNNEL PRACTICE

W. J. Boegly, Jr. and W. L. Griffith

ORNL-TM-1714

Contract No. W-7405-eng-26

Director's Division

CIVIL DEFENSE RESEARCH PROJECT

A SURVEY OF UNDERGROUND UTILITY TUNNEL PRACTICE

W. J. Boegly, Jr. and W. L. Griffith

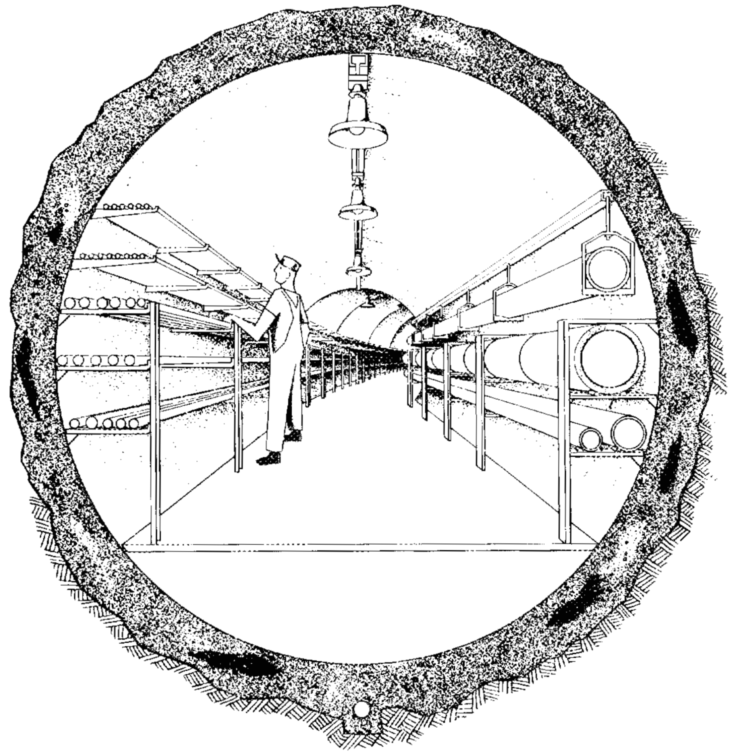
Prepared according to the terms of
Agreement No. OCD-PS-62-284 between
the Office of Civil Defense and the
U. S. Atomic Energy Commission,
under Work Unit 1624A

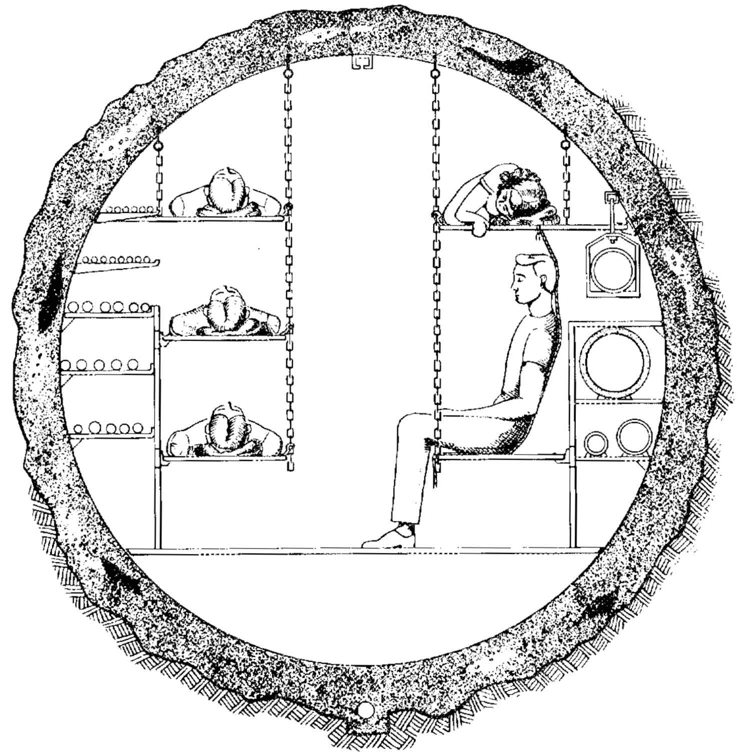
FEBRUARY 1967

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee
operated by
UNION CARBIDE CORPORATION
for the
U. S. ATOMIC ENERGY COMMISSION

CONTENTS

	Page
Abstract	1
Introduction	1
Summary of Results	2
Municipal Utility Tunnel Systems	2
Institutional Utility Tunnel Systems	3
Tunnel Construction	6
Tunnel Economics	8
Compatability of Utilities in the Same Tunnel	9
Conclusions	10
Appendix A	11
Appendix B	30
Appendix C	97
Appendix D	103
References	109





The Conversion of a 9-ft Tunnel for Shelter Use

A SURVEY OF CURRENT UNDERGROUND UTILITY TUNNEL PRACTICE

W. J. Boegly, Jr.[a] and W. L. Griffith[b]

ABSTRACT

A survey has been conducted on the use of underground, walk-through tunnels for utility systems. Results of this survey indicate that this concept has been successfully and extensively employed at universities and Government installations but is not commonly used in cities. There appears to be no set criteria or design for utility tunnels, and an optimization of the parameters is needed. Since many parallels exist between institutions and expected urban renewal projects, extrapolation of the utility tunnel concept to these projects appears worthwhile. Modifications to utility tunnels to incorporate civil defense shelter space appear possible, but further design studies are required.

INTRODUCTION

The Civil Defense Research Project at the Oak Ridge National Laboratory is engaged in a series of design studies to determine the feasibility of combining effective civil defense shelters with the peacetime use of various urban structures. As a part of this program, underground walk-through tunnels are being assessed.[c] Interest in utility tunnels arises from the possibility of special value of these structures as potential shelters in the event of nuclear attack (see frontispiece). In order

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(a) Health Physics Division.

(b) Process Analysis, Oak Ridge Y-12 Plant.

(c) The earliest ORNL design studies on interconnected urban shelter systems consisting of walk-through tunnels are contained in:

D. L. Narver and D. T. Robbins (Holmes and Narver, Inc.), Engineering and Cost Considerations for Tunnel-Grid Blast Shelter Concept, ORNL-TM-1183 (August 1965);

D. T. Robbins and D. L. Narver (Holmes and Narver, Inc.), Engineering Study for Tunnel Grid Blast Shelter Concept for a Portion of City of Detroit, Michigan, ORNL-TM-1223 (September 1965).

to develop a preliminary conceptual design of such a dual-use system, a survey was made to obtain available information on this concept.

Written and oral inquiries were made to determine where tunnel systems were used and what utilities were included. Contacts were made with cities, universities, government facilities, the American Gas Association, the Edison Electric Institute, the American Insurance Association, and the National Fire Protection Association. The information obtained is contained in the Appendices.

Use of underground tunnels in urban renewal areas provide a potential solution to a number of problems related to the use of city streets for material handling. First of these is the use of the tunnels for movement of solid wastes generated in the buildings in the renewal area. These wastes could be moved through the tunnels by: (1) compacting, packaging, and hauling through the tunnel by narrow gage railroads or rubber tired vehicles; or (2) by grinding and pumping through special pipelines installed in the tunnels either pneumatically or as an aqueous slurry. Secondly, the tunnels could be used to transfer goods to and from businesses located in the urban renewal area. Use of the tunnels for these purposes would minimize the need for heavy trucks operating on the streets of the urban renewal area.

SUMMARY OF RESULTS

1. Municipal Utility Tunnel Systems

Fairbanks, Alaska, has the only city-owned utility tunnel system of the 19 cities contacted in the survey (see Appendix A). The main reason cited for installing this system was to provide easy access and to prevent freezing. All utilities in the tunnels are city-owned, and include low-pressure steam, potable water (which is recirculated), telephone lines, and electric power. This system, which is six blocks long, was installed during the thirties. These tunnels have been satisfactory, but have not been extended because of the expense involved.

City-owned, underground conduit systems to accommodate electric power and communication systems are found in Baltimore and Montreal; however, no walk-through tunnels are utilized. Both organizations were set up under laws which provided authority to compel the utility companies to place their lines underground.

Baltimore's system[1] was installed to provide conduit space for telephone, power, telegraph, fire alarm, and traffic control lines. However, the telephone company built a separate system for their own use, citing interference as the reason for their separate system.

The Montreal system was established using the Baltimore system as a model[2]. It also is an underground conduit system for power distribution. Since the telephone company already had installed an extensive conduit system of their own when the Montreal conduit system was initiated, they have continued to operate separately.

Although the systems in Baltimore and Montreal are not walk-through tunnels, their administrative organization and operating philosophy could serve as a model for a tunnel system. Both Baltimore and Montreal have public and private utilities in their conduit systems. Money to construct the systems was raised by the city and is repaid by rental payments. Cost of rental is calculated to cover repayment of the bonds and operation and maintenance costs.

Administrative control of access to the conduit systems is by means of work permits and any work done on the lines in the conduit is performed under the supervision of a representative of the conduit system and is inspected by him for approval. This avoids conflicts between the individual users and controls access to the system.

Procedures of this type would certainly be necessary in a multi-utility tunnel system to protect the interest of the individual utilities. Also, the rental costs must be set on some basis that will insure a fair allotment of the costs to each utility.

San Francisco considered the use of utility tunnels in connection with their new rapid transit system, however, the proposal was abandoned because of conflicting requirements of the utility companies involved. The San Francisco proposal was not really a walk-through tunnel system, but rather a series of side-by-side concrete ducts, each duct to contain only one utility. Maintenance of the utilities would have required removal of the roof of the tunnels and interference with street traffic.

2. Institutional Utility Tunnel Systems

The information received from 26 universities and Government facilities is summarized in Table 1. (See Appendix B for listing of installations contacted and

Table 1. Summary of Information Received from Survey of Institutional Systems

Institution	Location	Heating System	Cooling System	Potable Water	Fuel Gas	Electric Power	Communications	Typical Size[a] (ft)	Remarks
Eielson Air Force Base	Fairbanks, Alaska	Steam	No	Yes	No	No	No	4.5 x 5	Sanitary sewers included.
Fort Wainwright	Fairbanks, Alaska	Steam	No	Yes	No	No	Yes	5 x 5	Sanitary sewers included.
University of Alaska	College, Alaska	Steam	No	Yes	No	Yes	No	6 x 6.5	Fire main included.
University of Arizona	Tucson, Arizona	Steam	Yes	Yes	No	Yes	Yes	4 x 6.5	Clock and class bell circuits, control circuits.
University of California	Irvine, California	Hot Water	Yes	No	Yes	No	No	8.5 x 11.5	Air lines.
University of Southern California	Los Angeles, California	-	-	-	-	-	-	-	Tunnels not used.
Civic Center Area	Los Angeles, California	Steam	Yes	Yes[b]	No	Yes	No	9 x 14	Diesel oil line, instrument air.
US Air Force Academy	Colorado Springs, Colorado	Hot Water	No	Yes	No	Yes[c]	Yes	-	
City and County Buildings	Denver, Colorado	Steam	No	Yes	Yes	No	No	-	600 feet of tunnel.
State Capitol Buildings	Denver, Colorado	Steam	No	Yes	No	Yes	Yes	5 x 7	1300 feet of tunnel.
University of Miami	Miami, Florida	-	-	-	-	-	-	-	Tunnels not used.
Florida Atlantic University	Boca Raton, Florida	Hot Water	Yes	No	No	Yes	Yes	20 x 6.25	Irrigation water, fire alarms, clock circuits, educational television.
University of South Florida	Tampa, Florida	-	-	-	-	-	-	-	Tunnels not used.
Georgia Institute of Technology	Atlanta, Georgia	Hot Water	No	No	No	Yes	No	-	New installation - Not walk-through.
Purdue University	LaFayette, Indiana	Steam	No	Yes[d]	No	Yes[d]	Yes	6.67 x 6.67	Control air lines, TV cable.
US Naval Academy	Annapolis, Maryland	-	-	-	-	-	-	-	Utilities mainly in trenches.
Michigan State University	East Lansing, Michigan	Steam	Yes	No	No	No	No	6 x 6.75	Demineralized water between power plants.
University of Minnesota	Minneapolis, Minnesota	Steam	Yes	No	No	Yes	Yes	5 to 7 x 7	Air lines.
University of Missouri	Columbia, Missouri	Steam	No	No	No	No	No	-	See Footnote e.
Cornell University	Ithaca, New York	-	-	-	-	-	-	-	Tunnels not used.
US Military Academy	West Point, New York	-	-	-	-	-	-	-	Tunnels not used.
University of Oklahoma	Norman, Oklahoma	Steam	Yes	Yes	No	Yes	No	4.5 x 6.5	Compressed air.
University of Oregon	Eugene, Oregon	Steam	Yes	Yes	No	Yes	Yes	6 x 7	TV cable, irrigation water, air.
University of Texas	Austin, Texas	Steam	Yes	No	No	No	No	6 x 6.5	Compressed air.
NASA	Houston, Texas	Steam	Yes	No	No	Yes	Yes	6.5 to 13 x 7.4	Compressed air, telemetry circuits.
University of Washington	Seattle, Washington	Steam	Yes	No	No	Yes	Yes	5 x 6.5	Compressed air, clock and bell circuits.

[a]First dimension is tunnel width and second dimension is tunnel height for rectangular sections.
[b]Six-inch cold soft water supply in copper pipe.
[c]Primary electric power not included. Secondary power only.
[d]New tunnels do not have water and electric power. Water lines are being removed from old tunnels for lack of space.
[e]Electric power distribution system has been removed from tunnels.

copies of replies received.) These results indicate that unlike the cities contacted, the use of walk-through utility tunnel systems is quite common.

This survey indicates that steam lines (or hot water) are associated with essentially all existing utility tunnel systems. This, at least in part, arises from the difficulty and expense of installing heating system lines satisfactorily by direct burial methods,although the decision to install tunnels at one site and not at another has been influenced by a number of factors. These factors include:

Factors favoring installation of tunnels

a. Easier accessibility for installation, inspection, maintenance, alteration, and expansion of utility lines.

b. Installation of lines in a less hostile environment.

c. Aesthetic considerations.

d. Fewer traffic problems and less interference with commerce because of torn-up streets.

Factors hindering installation of tunnels

e. Conflicting requirements of the utilities involved.

f. Economic restraints such as capital budgets, competition for funds within a project, etc.

g. Extent and usability of existing utilities in proposed tunnel area.

h. Concern over compatibility between the utilities required.

No instances have been found where users of utility tunnels would have preferred to have direct-burial systems. However, situations are known where the growth of utility requirements has exceeded the tunnel's capacity to hold the lines. In some instances this has been solved at minimum expense by removing some utilities from the tunnels. Thus, an essential prerequisite for a successful tunnel system is a good long-range master plan for future utility requirements.

Fuel gas exists in only two tunnel systems in the survey. A six-inch gas line is located in the 600-foot tunnel connecting two municipal buildings in Denver, and a four-inch gas line is contained in the University of California - Irvine system. In general, the gas companies and institutions are hesitant to include fuel gas in the tunnels.

Potable water is installed in about one-half of the tunnels surveyed. Michigan State University has commented that water is not included in their tunnels because of a concern with possible increases in water temperature. Purdue University is removing water mains from its old tunnels because of space requirements and is going to a direct burial system. Water is not included in their new tunnels. Increase in water temperature was the reason cited for this change. Apparently, an increase in water temperature is not a concern to the other users of tunnels which include potable water.

Electric power is contained in most of the tunnel systems reported although Michigan State University, Purdue University, and the University of Missouri expressed concern with the effect of temperature on cable capacity. These three universities have or are excluding power cables from their tunnels.

Table 1 also shows that a number of other utility lines are contained in the tunnels (see column on Remarks). These range from diesel oil to irrigation water.

3. Tunnel Construction

In general, reinforced concrete in rectangular cross-section is most frequently utilized for tunnels installed in slit trenches and circular cross-sections are used when tunnels are bored. Typical tunnel cross-sections are shown in Fig. 1. Although the concrete is usually poured in place, round and elliptical precast sections have been used for utility tunnels for institutions[3] and under expressways[4]. Rectangular culverts utilizing precast sections and precast cable ducts have also been installed[5,6]. Steel sections manufactured by Armco Steel (Armco Multi Plate) and Republic Steel have also been used for tunnels accommodating chemical process lines and utility lines under railroads, etc., and for pedestrian tunnels. Ric-Wil, Inc., routinely manufacturers prefabricated utilidors utilizing steel sections for the shell.

When tunnels contain both electric power lines and steam lines, they are usually ventilated to keep the temperature at a reasonable level. At the NASA Manned Spacecraft Center, the tunnel is protected with high temperature alarms. In many cases the tunnels are lighted. Frequently, the tunnels are placed under sidewalks to facilitate snow removal. Of course, this can be done only with fairly

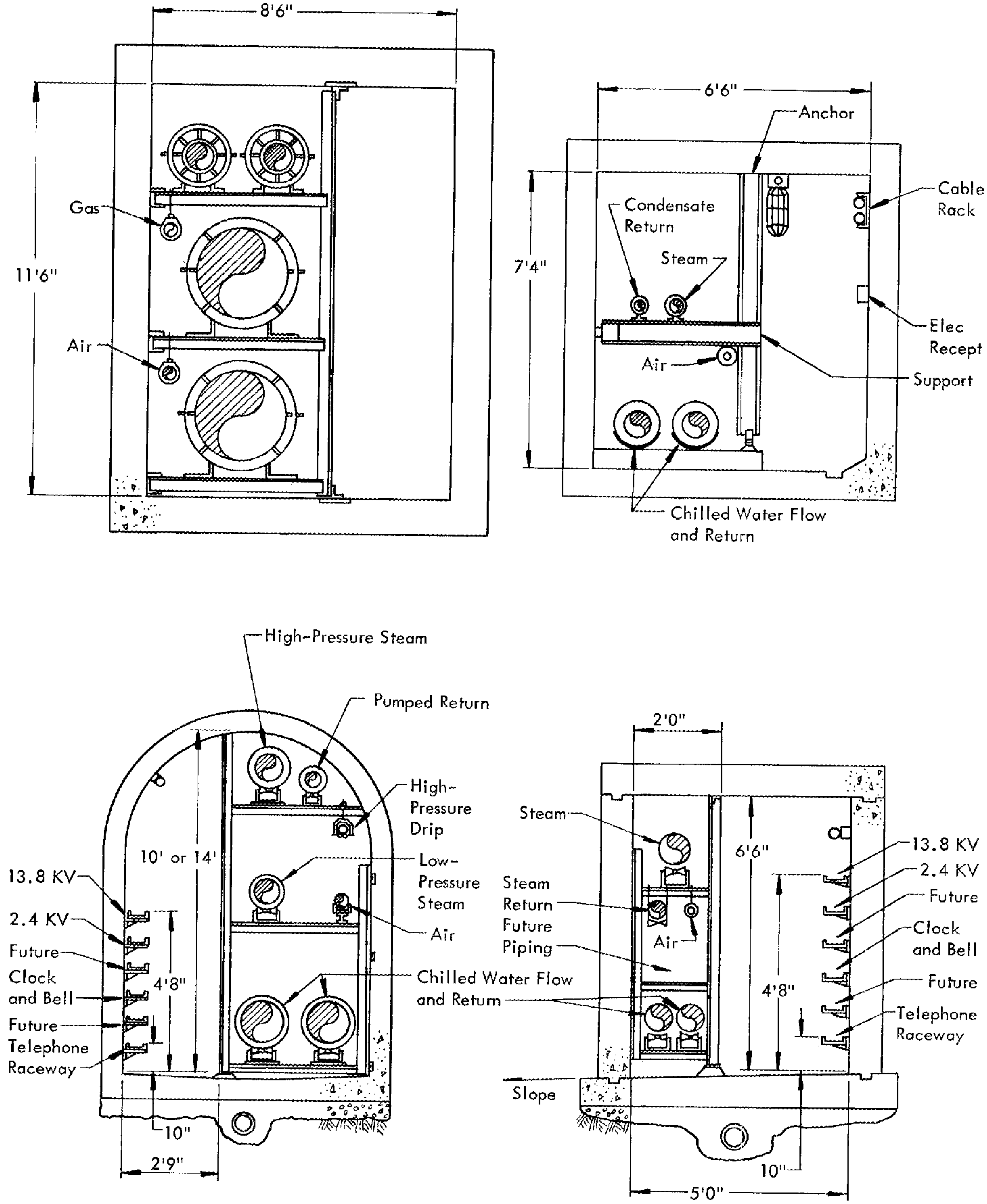


Fig. 1 - Typical Utility Tunnel Sections. Upper left: tunnel with fuel gas line at University of California Campus - Irvine; Upper right: small tunnel at NASA Manned Space Craft Center, Houston; Lower left: University of Washington tunnel constructed by tunneling; Lower right: University of Washington tunnel constructed by open cut method.

level ground and careful attention to grades. It has been reported that the forces caused by pipe expansion have caused unexpected difficulty in some instances resulting in bolt or concrete failure. The Montreal International Airport tunnel system was laid out in a zig-zag pattern to avoid this problem, by eliminating the need for expansion joints, as such[7]. Typical tunnel cross-sections, system layouts, etc., for individual systems are presented in the Appendices.

Most of the tunnel systems contained in this survey are not deeply buried. Two institutions, the University of Minnesota and the University of Washington, use deep bored tunnels. One feature of the deep tunnel (reported by the University of Washington) is the lack of interference between the deep tunnels and new building construction, and the flexibility provided in the future location of new buildings.

4. Tunnel Economics

The NASA Manned Spacecraft Center in Houston has a modern system of utility tunnels to accommodate all heating and cooling piping, and electrical and signal circuits. As a result of a study to determine the most economical type of tunnel, assuming an H-20 load, a reinforced concrete box-type tunnel was selected. Typical costs in 1963 for tunnels of this type excluding excavation or installed utilities ranged from 100 $/ft for 6.5 ft x 7.3 ft, to 240 $/ft for 13 ft x 7.3 ft tunnels. Additional information on the tunnels at the NASA site are presented in Appendix B.

A 1965 study at the University of Illinois showed it to be more economical to use tunnels rather than conduits when three or more pipes were to be installed. Likewise, the cost of installing piping over four inches in diameter in tunnels was found to be cheaper than installation in conduits for an application at Camp Gagetown, New Brunswick[8].

Michigan State University reports that an underground tunnel system is no more expensive than a high quality, buried steam and return system, when the pipes required are large (18-inch steam, 10-inch return). They further state that reduced maintenance costs and future pipe space obtained with a tunnel system more than offset the additional cost of a building service.

5. Compatibility of Utilities in the Same Tunnel

As pointed out above, all of the institutional utility tunnels surveyed are associated with central heating or cooling. They typically contain steam (or hot water), chilled water, and the associated returns. As may be seen from Fig. 1, electric power and signal circuits are frequently installed in ventilated tunnels. Irrigation water, potable water, and compressed air were also reported in several instances. In two instances, fuel gas has been installed in a tunnel system. Discussions with representatives of the American Insurance Association, National Fire Protection Association, American Gas Association, and the Edison Electric Institute indicated that little experience in this area is available and reflected deep concern about the advisability of installing gas lines in utility tunnels under city streets. However, it was pointed out that tunnels would offer a solution to the serious problem of undetected leaks in buried gas lines (the so-called substructure problem) since tunnels would make it possible to monitor the gas lines for leaks.

Tunnels have been built to carry gas mains under rivers, etc. On of the best known examples is the Astoria Tunnel, built in 1915[9], to carry two cast-iron 72-inch gas mains under the East River. The mains were removed in 1963 to clear the tunnel to carry electric cables[10]. The Hudson River Tunnel, under the East River, will contain 345 kv transmission lines, and pipes for gas, steam, and oil[11].

Parliamentary approval was given to placing two 18-inch gas mains in the new Dartford tunnel (vehicular) under the Thames River. The lines were to be placed either overhead or in the ventilation ducts under the carriageway floor. Gas lines have also been installed in pedestrian tunnels under the Tyne River in England and the Maas River in Holland.

The replies received and information collected by telephone contacts commonly indicates concern about incompatibility between various utility combinations which could be included in a tunnel system (steam lines and potable water; steam lines with electrical power cables). As shown in Table 1, these utilities are combined quite often. If the tunnels are ventilated, it appears that this problem can be alleviated. Exactly what criteria have been used in decisions to install various utilities in tunnel systems are not clear. Apparently, decisions have been influenced by the attitude of the individual utility companies or the organizations responsible for the design of the tunnel system. As an example, telephone lines are included in some tunnel systems, and not in others.

Sewers are not included in the reported tunnel systems, except those in Alaska where freezing is a problem. Apparently, gravity flow and burial depth rule them out in most instances; however, where pumped sewers are used (such as those in Alaska), there appears to be no reason why sewers could not be included.

CONCLUSIONS

1. The utility tunnel concept has been extensively and successfully employed in institutional applications involving central heating (and cooling) systems.

2. There are many parallels between institutions and expected major urban renewal projects involving high rise buildings in high density areas. Extrapolation of the institutional experience to these urban renewals appears promising and worthy of effort.

3. There are no set designs or criteria for utility tunnels. Optimization of parameters and development of general criteria is needed.

4. Modifications to these institutional/urban renewal utility tunnels to obtain blast shelter space appear possible. Further work is needed to determine the costs associated with such a modification.

5. Sewer systems could be included in tunnels if pumped systems instead of gravity flow were used. The economies of pumped sewers are not well known, but there is reason to believe that the added cost of pumps and auxiliary power supplies will be substantially balanced by the savings resulting in the reduced size of the sewers. More detailed study should be given to this problem.

6. Studies should be initiated on the potential use of tunnels for solid waste handling, or for transfer of materials to and from buildings.

APPENDIX A - SURVEY OF CITIES ON UNDERGROUND UTILITY TUNNELS

Inquiries were sent to the Department of Public Works in seventeen cities to determine if underground utility tunnels are used. Replies were received from the cities listed below:

Anchorage, Alaska	New Orleans, Louisiana
Fairbanks, Alaska	Grand Rapids, Michigan
Tucson, Arizona	Minneapolis, Minnesota
San Francisco, California	St. Louis, Missouri
San Jose, California	Oklahoma City, Oklahoma
Denver, Colorado	Salt Lake City, Utah

Based on the information received, only Fairbanks, Alaska has a city-owned utility tunnel system. Baltimore, Maryland and Montreal, Canada were contacted by telephone, and have city-owned conduit systems for electric power and communication circuits. The information received from these cities is summarized below:

1. Baltimore, Maryland

Mr. James G. Fairbanks in the Bureau of Electrical and Mechanical Service explained that walk-through tunnels are not utilized; however, Baltimore does have a city-owned conduit system used primarily for power transmission. The system was financed by bonds authorized by a referendum. The current revenue of about $1,000,000 per year makes the system self-sustaining. The largest conduit is 5 inches and the there is a manhole every 200 to 300 feet. The system also carries Western Union lines, fire alarm, traffic control, etc. Although originally included, the telephone company has built a dual system for their use. Interference was cited as a reason to separate and to build a separate system.

2. Montreal, Canada

Mr. J. C. Nepveu, president and chief engineer of the Electrical Commission of the City of Montreal, sent a copy of a paper[2] describing the Montreal Conduit System which is patterned after the Baltimore system and a copy of the by-laws of the Commission.[12] Important comments concerning use, financing, and operation of the system include:

a. The Bell Telephone Company installed a conduit system of its own around 1890 and it has continued to be operated separately.

b. The city has authorized, by law, to issue bonds or debentures, up to 10 million dollars; the proceeds of these loans were used for capital expenditures to construct and establish the conduit system. Although the maximum of 10 million was reached in 1955, the city has continued to loan the Commission the required funds for the extension of the system.

c. The rental rate in 1962 was 6.7 cents per duct foot.

d. The lessees install and service their own cables. Their work must comply in every respect with the rules and regulations governing the operation of the system, as approved by the Public Service Board of the Province of Quebec. The most important of these rules and regulations may be summarized as follows:[13]

   1) The tools and appliances and working methods used by the lessees must be approved by the Commission.

   2) Any employee of a lessee, who disregards these rules and regulations, may, at the discretion of the Commission, be prohibited access to any manhole or part of the system.

   3) Lesees will not enter manholes without being issued a permit by the Commission.

4) Before entering a manhole, care must be taken to see that there is no danger due to the presence of inflammable or explosive gas.

5) No cable shall have an over-all diameter exceeding 2.75 inches nor be operated at over 13,500 volts between conductors. (Conduit inside diameter is 3.5 inches.)

6) Cables must be racked to position as soon as pulled in; they shall not be in contact with manhole walls, racks, nor other cables.

7) Cables must be bonded and grounded according to specific rules. Five cable inspectors, three of whom work exclusively with Hydro-Quebec's field crews, supervise the installation of cables. They issue the permits, allot the ducts in which cables are to be pulled and supervise the pulling, training, and splicing operations. They periodically report to the office on the construction and installation defects which may have been noted.

3. <u>San Francisco, California</u>

The city of San Francisco considered utility tunnels in conjunction with their new rapid transit system. However, the proposal was abandoned because of the conflicting requirements of the several utility companies involved. Details of their concept and the comments of the utility companies involved are presented in this Appendix.

4. <u>Denver, Colorado</u>

The reply from the City of Denver indicated that the underground utility tunnels are not used by the City except in two institutional type systems connecting City and County buildings. One of these systems contains a 6-inch fuel gas line. Details on these systems are presented in Appendix B with the other institutional systems.

City of Fairbanks
BOX 790
FAIRBANKS, ALASKA
99701

Office of the
Director of Public Works

September 12, 1966

Mr. W. J. Boegly, Jr.
Health Physics Division
Oak Ridge National Laboratory
Post Office Box X
Oak Ridge, Tennessee 37831

Dear Sir:

Yes, the City of Fairbanks has some six blocks of underground utilities in our central downtown area.

These utilidors contain low pressure steam and condensate lines that are used for heating adjacent buildings. They also contain city water mains, city telephone lines and some electrical distribution lines.

These utilidors are constructed of "Z-Crete", a light weight concrete with insulating properties and the wall and roof are about one foot thick. The inside dimensions are four feet wide and six feet tall with access openings about every 200 feet.

Sincerely,

E L Martin

Edward L. Martin
Director of Public Works

ELM:kh

MEMORANDUM OF CONFERENCE OR CONVERSATION

DATE: September 19, 1966

TIME:

[X] TELEPHONE [ ] PERSONAL

ORIGINATING PARTY	OTHER PARTIES
W. L. Griffith	Mr. E. L. Martin
W. J. Boegly, Jr.	Director of Public Works, Fairbanks, Alaska

SUBJECT: Additional Data and Drawings on Fairbanks, Alaska Utility Tunnels

DISCUSSION:

The letter received from Mr. E. L. Martin in Fairbanks was followed up with a telphone call September 19, 1966.

The six blocks of city-owned tunnel system was installed in the thirties during the Depression. Its purpose was to provide access and help prevent freezing. All utilities installed are city-owned and include low-pressure steam, potable water (recirculated), and electric power. No sewers are included. No fuel gas is distributed by pipeline in Fairbanks.

Mr. Martin reported that the University of Alaska at College, Fort Wainwright, and Eielson Air Force Base have extensive and more modern systems. Some include sewers.

Mr. Martin agreed to send us sections and plan drawings of the Fairbanks, Alaska system.

CONCLUSION OR AGREEMENTS

DISTRIBUTION:

SIGNED

UCN-693
(123 7-59)

City of Fairbanks

BOX 790
FAIRBANKS, ALASKA
99701

Engineering Division

September 29, 1966

Mr. W. J. Boegly, Jr.
Health Physics Division
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831

Dear Mr. Boegly:

Mr. Martin, the Public Works Director for Fairbanks, has asked that I send you copies of typical sections and plans for existing utilidors in this area.

The attached sections and plan drawings are for the existing utilidors in the City of Fairbanks. We contacted the University of Alaska (they have a limited utilidor system) and were told they would furnish us with drawings of their system. They have not yet prepared the prints so we are forwarding the attached and will send the U. of A. prints under separate cover when we get them.

We also contacted the Post Engineer's office on Fort Wainwright. They said that they did not feel at liberty to let these prints out but that if you wrote directly to them they might be able to help.

I hope what we are able to furnish will be of assistance to you.

Very truly yours,

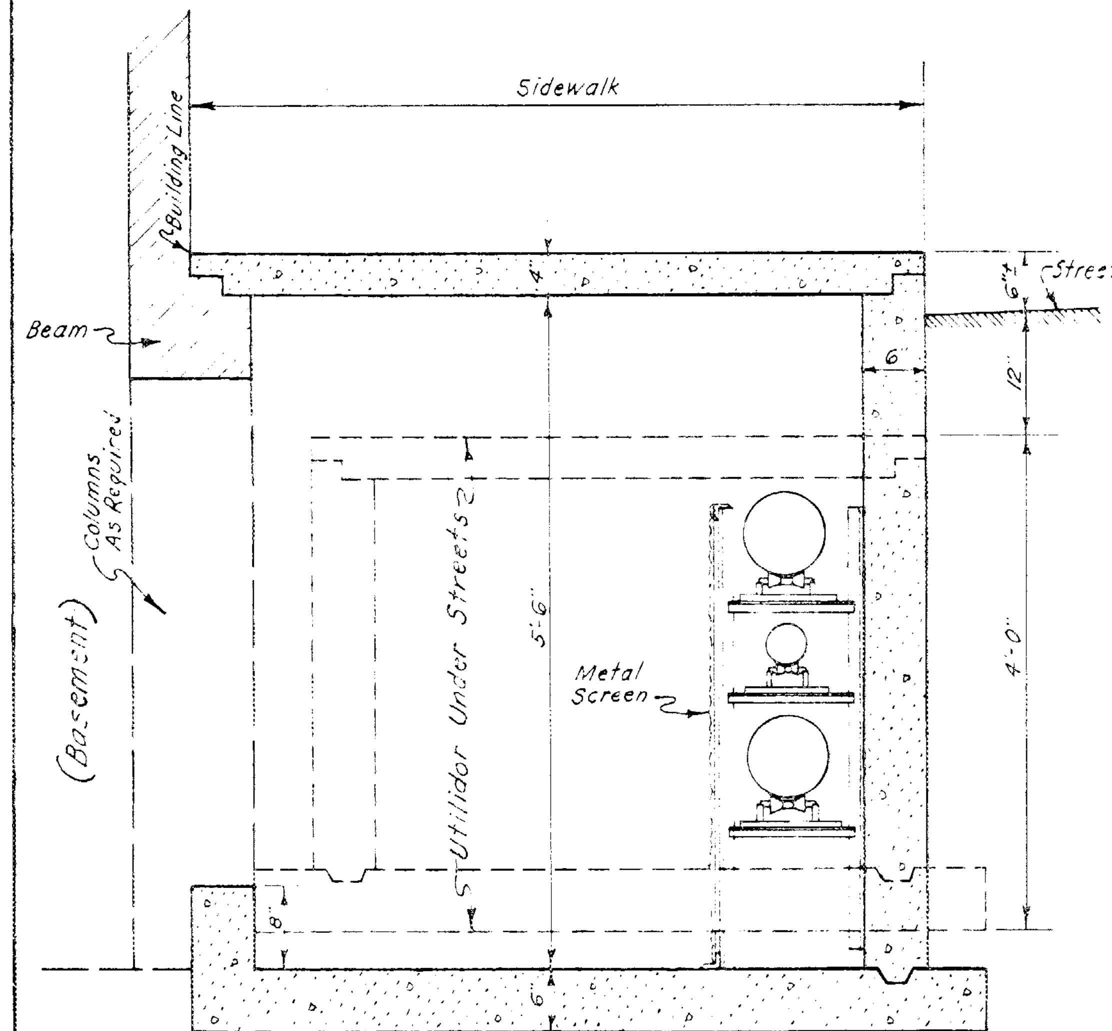
David J. Harman

David J. Harman, P. E.
City Engineer

DJH:kh

Attachments: a/s

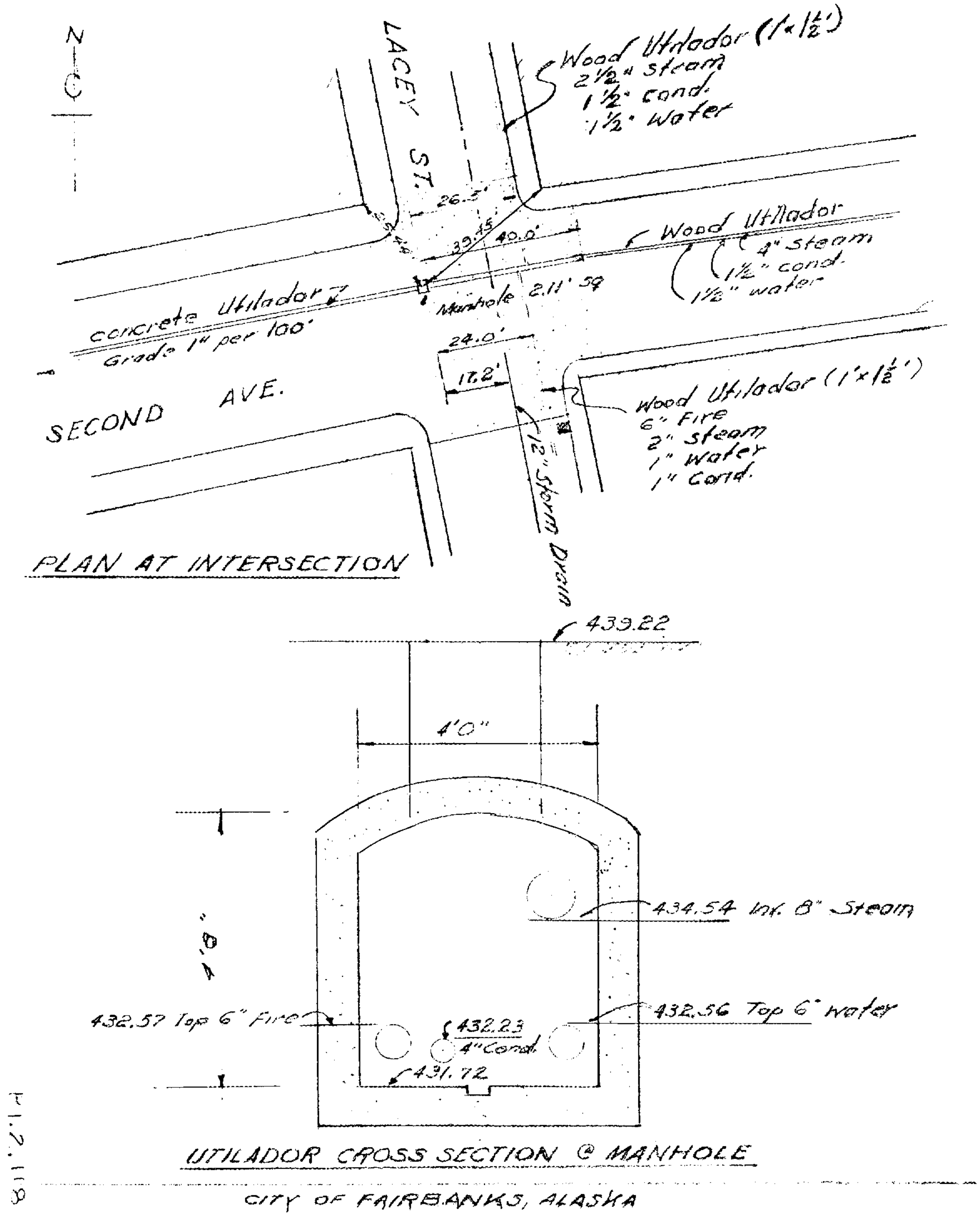

NOBLE ST.
LACEY ST.
CUSHMAN ST.
FIRST AVE.
SECOND AVE.
THIRD AVE.
FOURTH AVE.
FIFTH AVE.
SIXTH AVE.
CHENA RIVER
CHENA R. BRIDGE
INVERT EL. OF SEWER
EXISTING SEWER
END OF EXISTING N.C. UTILITIES
EXISTING UNDER-GROUND DRAIN
WATER
CONDENSATE
STEAM
WOOD M.H. 40"x40"
6"FIRE
8"STEAM
4"RETURN
6"WATER
EXISTING N.C. UTILITIES
EXISTING UTILIDOR
CONCRETE PAVEMENT BRIDGE THROUGH FIFTH
EXISTING UTILIDOR
PROPOSED UTILIDOR
8"WATER
4"CONDENSATE
8"STEAM
End of Stage I Construction Flange Ends For Future Extension
TOP PLATE LAPPED AS SHOWN FOR EASY REMOVAL TO ENTER STRUCTURE.
Varies 12"Min.
8"STEAM
4"CONDENSATE Grade 1/1000'
8"WATER
PLATFORM VARIABLE HEIGHT
4'-0"
2'-0"
Varies
8"Sewer
PROPOSED UTILIDOR
ARMCO MULTI PLATE
N.C. Power House
LOCATION MAP
CITY of FAIRBANKS
PROPOSED UTILITIES EXTENSIONS TO BLOCK 46
CITY ENGINEERS DEPT.
SCALE



TYPICAL SECTION ADJACENT TO NEW CONSTRCTION

SCALE 3/4" = 1'-0"

CITY OF FAIRBANKS ENGINEERING OFFICE PLATE Nº 2



CITY OF FAIRBANKS, ALASKA

EXISTING UTILADOR AT SECOND AND LACEY ST.

CITY ENGINEER DEPT. MAR. 30, 1950

B1.2.118

MEMORANDUM OF CONFERENCE OR CONVERSATION

DATE: See Below
TIME:
[X] TELEPHONE [ ] PERSONAL

ORIGINATING PARTY	OTHER PARTIES
W. L. Griffith	Mr. James G. Fairbank
	Bureau of Electrical and Mechanical Service
	Baltimore, Maryland

SUBJECT: Underground Utility Tunnels in Baltimore, Maryland

DISCUSSION:

August 17, 1966

Called Mr. Fairbank about Baltimore underground utility system.

Mr. Fairbank is in the Bureau of Electrical and Mechanical Services and explained that walk-through tunnels are not utilized; however, Baltimore does have a city-owned conduit system used primarily for power transmission. The system was financed by bonds authorized by a referendum. The current revenue of about $1,000,000 per year makes the system self-sustaining. The largest conduit is 5 inches and there is a manhole about every 200 to 300 feet. The system also carries Western Union lines, fire alarm, traffic control, etc. Although originally included, the telephone company has built a dual system for their use. Interference was cited as a reason to separate and to build a separate system.

November 3, 1966

Mr. Fairbank was called to obtain more information about the organization and operation of the Baltimore conduit system. He said he would send us pertinent information on their system.

CONCLUSION OR AGREEMENTS

DISTRIBUTION:

SIGNED

UCN-693
(123 7-59)

MEMORANDUM OF CONFERENCE OR CONVERSATION

DATE: See Below | TIME: | [X] TELEPHONE [ ] PERSONAL

ORIGINATING PARTY	OTHER PARTIES
W. L. Griffith	J. C. Nepveu, Eng.
	President and Chief Engineer
	The Electrical Commission of the City of Montreal

SUBJECT: City of Montreal, Canada Underground Conduit System

DISCUSSION:

August 18, 1966

Mr. Nepveu was called as a result of our contact with Mr. Fairbank of the Bureau of Electrical and Mechanical Service, Baltimore, Maryland. Mr. Nepveu has recently completed a tour of cities in the USA to obtain experience on underground utility systems. Mr. Nepveu volunteered to send a paper describing the Montreal System, a copy of the by-laws of the Commission, and a copy of his trip report, when available.

November 4, 1966

Called Mr. Nepveu about availability of trip report. Report will not be available for some time. He also promised to send a copy of the detailed rules and regulations governing underground conduits in Montreal.

CONCLUSION OR AGREEMENTS

DISTRIBUTION: | SIGNED

UCN-693
(123 7-59)

PLACE CREMAZIE
110 OUEST, BOUL. CRÉMAZIE
SUITE 900, MONTREAL 11

TEL. 384-6841

PLACE CREMAZIE
110 CREMAZIE BLVD. WEST
ROOM 900, MONTRÉAL 11

LA COMMISSION DES SERVICES ELECTRIQUES DE LA VILLE DE MONTREAL

THE ELECTRICAL COMMISSION OF THE CITY OF MONTREAL

CABINET DU
PRÉSIDENT ET
INGÉNIEUR EN CHEF

August 18, 1966.

Mr. W.L. Griffith,
Union Carbide Corporation,
P.O. Box "Y",
Bldg. 9704-2
OAK RIDGE, Tenn.,
U.S.A.

Dear Mr. Griffith:

Pursuant to our telephone conversation of even date I take pleasure in sending you copy of a paper which I presented at the Winter Convention of the Canadian Electrical Association in 1962. This documentation gives a thorough description of the structure of the Commission, its aims, legal authority, financial structure, etc.

In addition to this, I also enclose a copy of " Recueil des Lois et Règlements ".

Hoping that this information will be of assistance to you, I remain,

Yours very truly,

J. C. Nepveu, Eng.,
President and Chief Engineer.

JCN/PLB

Ref.: Eng. 50-1

CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS

BUREAU OF
ENGINEERING

351 CITY HALL
SAN FRANCISCO
CALIFORNIA 94102

September 14, 1966

513
Information on
Utility Tunnels

Mr. W. J. Boegly, Jr.
Health Physics Division
Oak Ridge National Laboratory
Post Office Box X
Oak Ridge, Tennessee 37831

Dear Mr. Boegly:

Reference is made to your letter of August 26, 1966, regarding the use of utility tunnels in San Francisco.

Utility tunnels are not used in San Francisco at the present time. The practicability of their use was considered in connection with Rapid Transit construction but conflicting requirements of the several utility companies resulted in abandonment of the proposal.

Very truly yours,

S. M. Tatarian
Director of Public Works

By Clifford J. Geertz
City Engineer

MEMORANDUM OF CONFERENCE OR CONVERSATION

DATE	TIME		
October 6, 1966		[X] TELEPHONE	[ ] PERSONAL

ORIGINATING PARTY	OTHER PARTIES
W. L. Griffith	J. Walsh
W. J. Boegly, Jr.	San Francisco Dept. of Public Works

SUBJECT:

Additional Information on Use of Utility Tunnels in Conjunction with the San Francisco Bay Area Rapid Transit District

DISCUSSION:

Called Mr. Geertz about additional information on use of utility tunnels in conjunction with rapid transit system. Mr. Geertz was not in and we talked with Mr. J. Walsh.

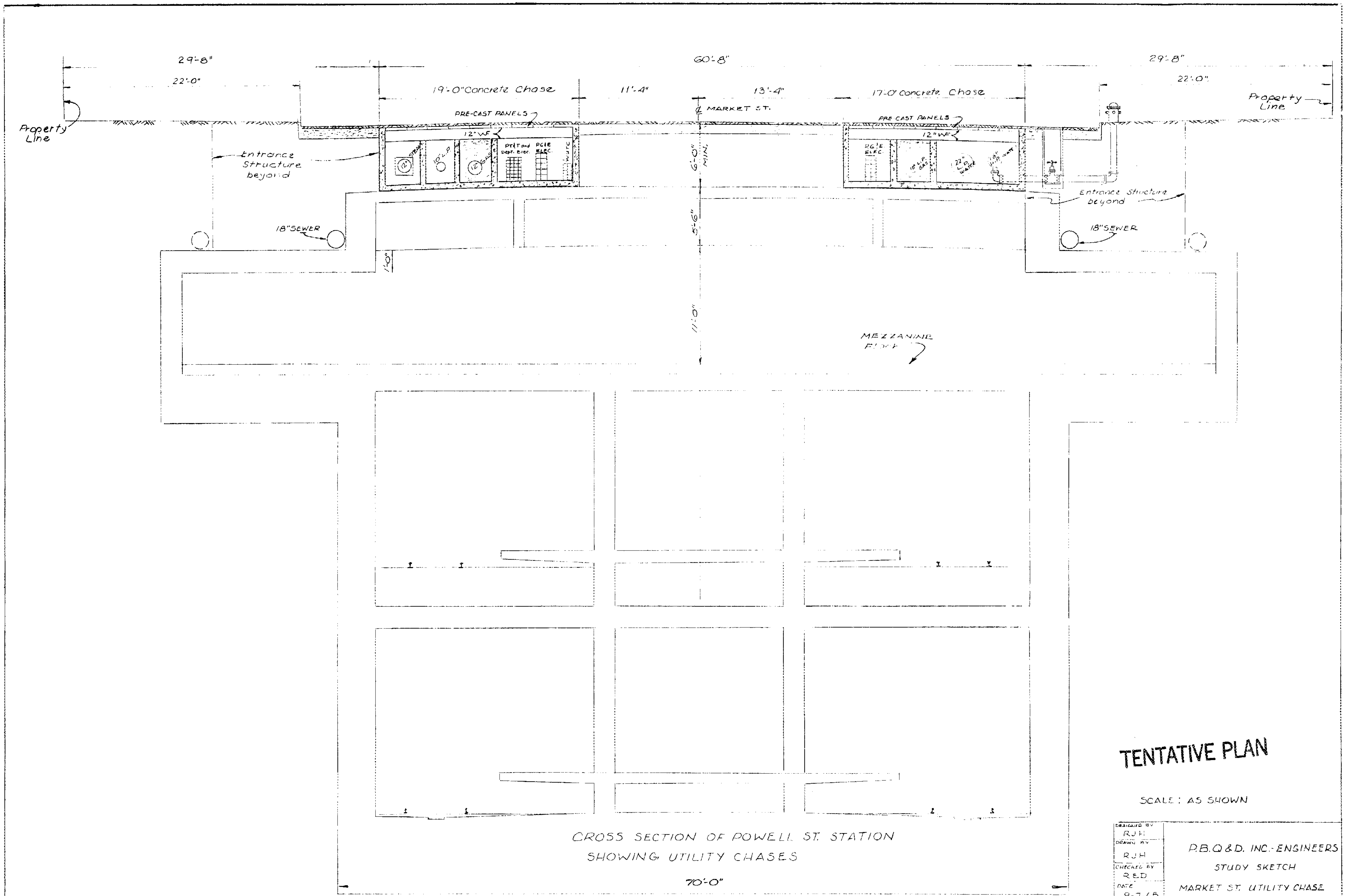
Mr. Walsh offered to contact Parsons, Brinkerhoff, Quade, and Douglas to obtain drawings and additional information on the reasons why the proposed concept was not used.

CONCLUSION OR AGREEMENTS

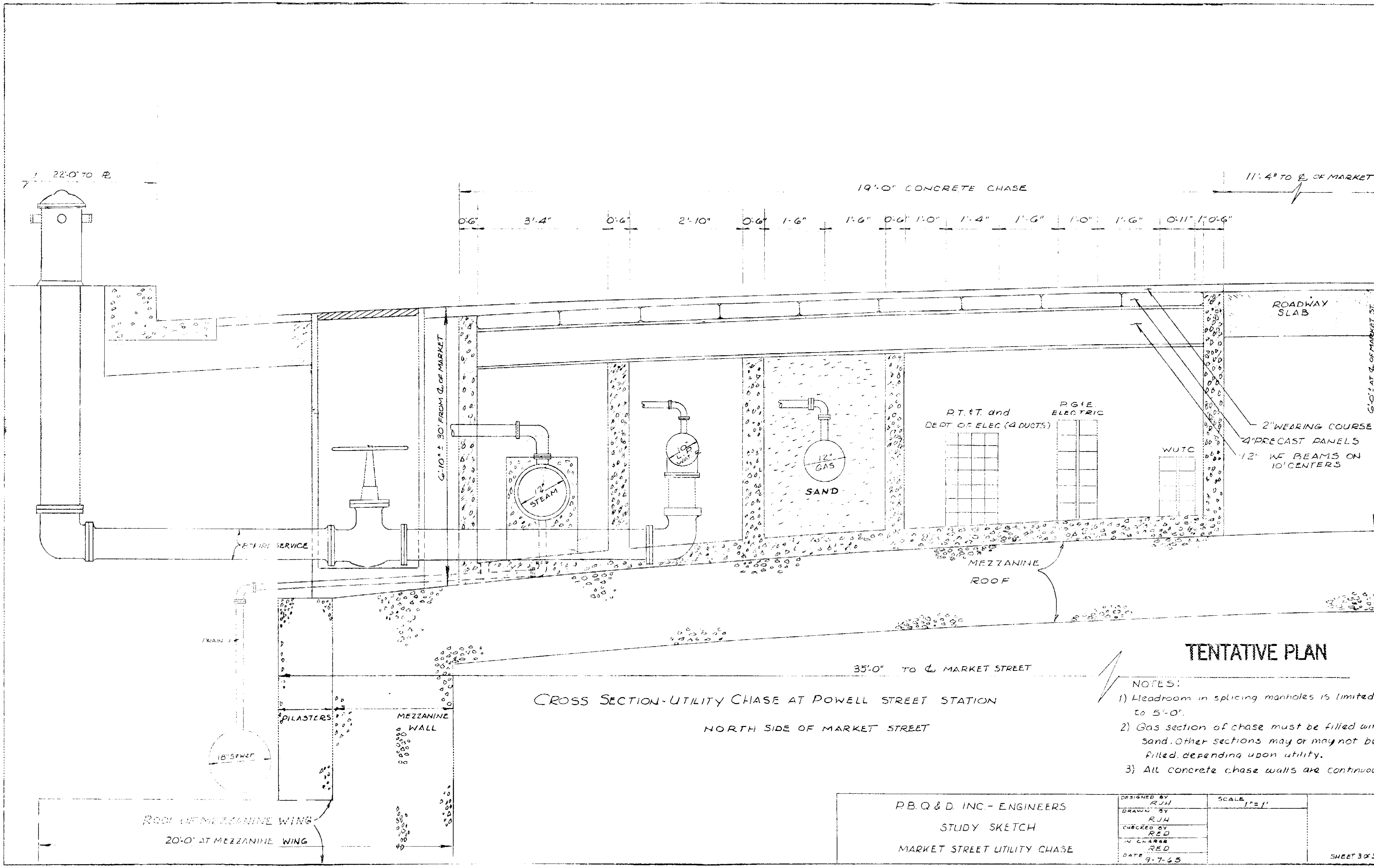
DISTRIBUTION:

SIGNED

UCN-693
(123 7-59)



CROSS SECTION OF POWELL ST. STATION
SHOWING UTILITY CHASES


22'-0" TO ℄
19'-0" CONCRETE CHASE
11'-4" TO ℄ OF MARKET
0'-6" 3'-4" 0'-6" 2'-10" 0'-6" 1'-6" 1'-6" 0'-6" 1'-0" 1'-4" 1'-6" 1'-0" 1'-6" 0'-11" 1'-0"-6"
ROADWAY SLAB
6'-0" AT ℄ OF MARKET ST.
6'-10" ± 30' FROM ℄ OF MARKET
12" STEAM
10" L.P. WATER
12" GAS
SAND
P.T.&T. and
DEPT OF ELEC (4 DUCTS)
P.G.&E. ELECTRIC
WUTC
2" WEARING COURSE
4" PRECAST PANELS
12" WF BEAMS ON 10' CENTERS
8" FIRE SERVICE
MEZZANINE ROOF
DRAIN
35'-0" TO ℄ MARKET STREET
PILASTERS
MEZZANINE WALL
18" Sewer
ROOF OF MEZZANINE WING
20'-0" AT MEZZANINE WING
CROSS SECTION - UTILITY CHASE AT POWELL STREET STATION
NORTH SIDE OF MARKET STREET
TENTATIVE PLAN
NOTES:
1) Headroom in splicing manholes is limited to 5'-0".
2) Gas section of chase must be filled with sand. Other sections may or may not be filled, depending upon utility.
3) All concrete chase walls are continuous.
P.B.Q.&D. INC. - ENGINEERS
STUDY SKETCH
MARKET STREET UTILITY CHASE
DESIGNED BY RJH
DRAWN BY RJH
CHECKED BY RED
IN CHARGE RED
DATE 9-7-65
SCALE 1"=1'
SHEET 3 of 3

JOHN E. EVERSON
VICE PRESIDENT

WINFIELD O. SALTER
VICE PRESIDENT

PBQ&D, INC.
ENGINEERS

25 MAIDEN LANE, SAN FRANCISCO, CALIF. 94108
986-2929 TELEX: 03-4763 CABLE PARKLAPSF

Affiliated with Parsons, Brinckerhoff, Quade & Douglas

October 20, 1966

Mr. W.J. Boegly , Jr.
Health Physics Division
Oakridge National Laboratory
Post Office Box X
Oakridge, Tennessee

Dear Mr. Boegly:

We have received a request from Mr. J. Walsh, of the San Francisco Department of Public Works, to furnish you with available data and background information concerning studies made here of the "utility chase" method of handling utilities. These studies were made at the request of our client, the San Francisco Bay Area Rapid Transit District, for the use of the City and County of San Francisco, who reasoned that the "zipper" approach to utility maintenance would be attractive to both public and private utilities.

The enclosed drawings indicate what was proposed and the attached letter dated November 11, 1965 from me to Mr. W.A. Bugge, summarizes the reactions of the utility entities. In general, public utilities (City) were either neutral or accepted the chase idea. The private utilities, however, were unanimous in finding the chase unacceptable. Since the utility facilities we have to contend with are overwhelmingly those of private companies, we recommended that the Rapid Transit District adopt a more conventional approach to utility handling.

Beyond the specific findings related to our Market Street subway, we found some general incompatibilities usually exist which at least reflect on design of a combined utility tunnel or chase. Combination of water lines and power distribution facilities could result in a water main break shorting out the power system. Combination of telephone and power ducts may cause adverse inductive interactions, and hazardous working conditions for telephone linemen. Inclusion of gas lines may be particularly hazardous producing potential bombs beneath the streets.

Mr. W. J. Boegly, Jr.
Page two
October 20, 1966

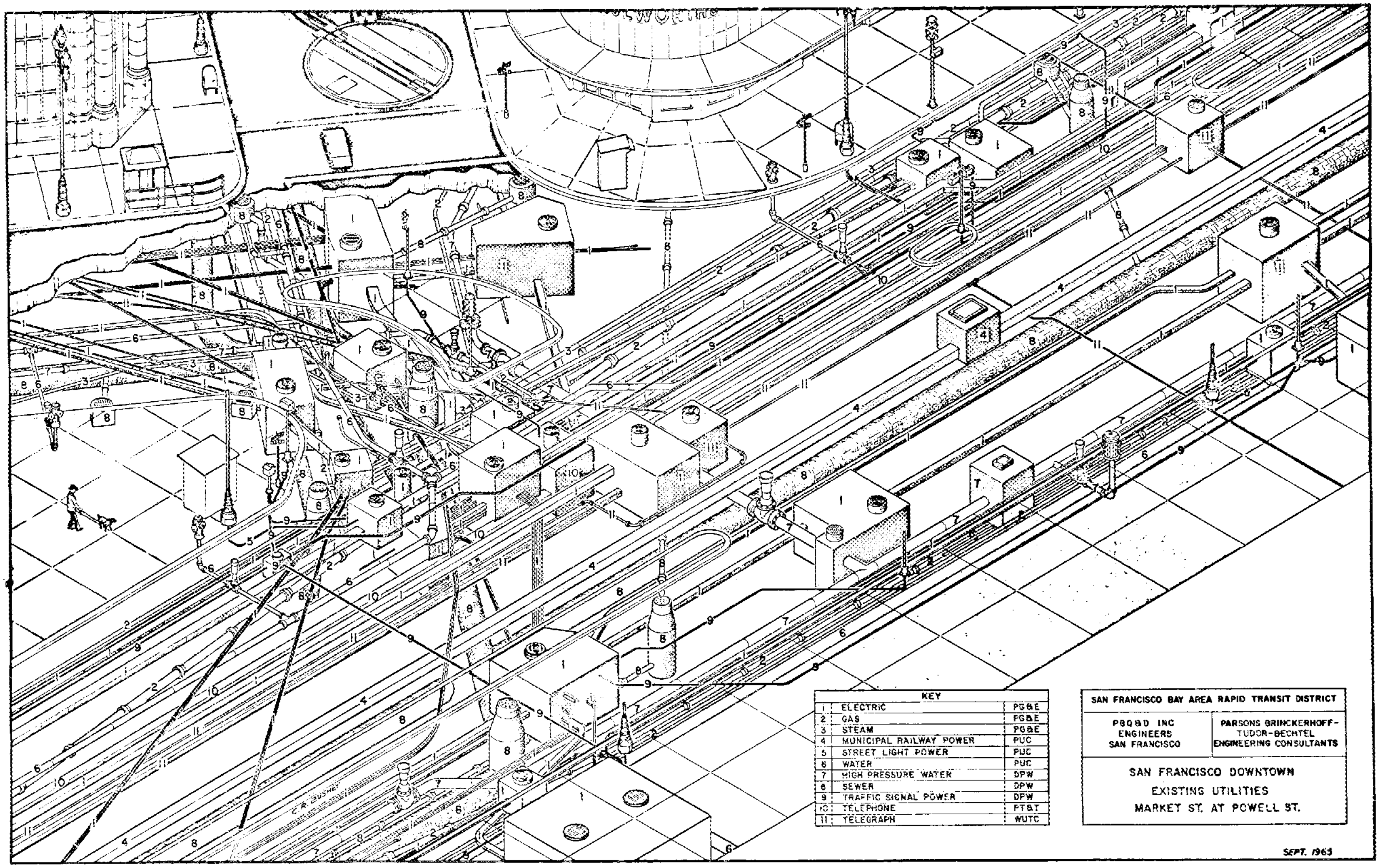
Our investigations of existing utility handling procedures throughout the country did reveal that short utility tunnel runs, such as those carrying several utilities under rivers or interconnecting hospital buildings, have been used to some extent. (Refer to the attached letter from New York City) State and City fire codes as well as insurance restrictions, labor agreements, and legal aspects should be investigated, as they may affect design and influence the feasibility of combining different services in a single structure.

Very truly yours,

PBQ&D, Inc.

W.O. Salter

WOS/cr
Enclosures
cc: Mr. J. Walsh, San Francisco Dept. of Public Works



KEY		
1	ELECTRIC	PG&E
2	GAS	PG&E
3	STEAM	PG&E
4	MUNICIPAL RAILWAY POWER	PUC
5	STREET LIGHT POWER	PUC
6	WATER	PUC
7	HIGH PRESSURE WATER	DPW
8	SEWER	DPW
9	TRAFFIC SIGNAL POWER	DPW
10	TELEPHONE	PT&T
11	TELEGRAPH	WUTC

SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT

PBQ&D INC
ENGINEERS
SAN FRANCISCO

PARSONS BRINCKERHOFF-
TUDOR-BECHTEL
ENGINEERING CONSULTANTS

SAN FRANCISCO DOWNTOWN
EXISTING UTILITIES
MARKET ST. AT POWELL ST.

SEPT. 1963

APPENDIX B - SURVEY OF INSTITUTIONAL UTILITY TUNNEL SYSTEMS

Since most of the known utility tunnel systems appeared to be institutional, inquiries have also been sent to the Director of the Physical Plant of eighteen universities. A typical letter of inquiry is reproduced below. The universities contacted were:

- University of Alaska
- University of Arizona
- Florida Atlantic University
- Georgia Institute of Technology
- University of Miami
- Michigan State University
- University of Minnesota
- University of Missouri
- Cornell University
- University of Oregon
- Purdue University
- University of Southern California
- University of Texas
- University of Southern Florida
- U. S. Air Force Academy
- U. S. Military Academy
- U. S. Naval Academy
- University of Washington

These replies are reproduced on the following pages of this Appendix.

Based on the information received to date, essentially all of the universities have utility tunnel systems associated with their central heating facility.

The University of Oklahoma was contacted by telephone as a result of the reply from the University of Missouri. The results of the inquiry are presented in this Appendix, however, no flammable gas lines are accommodated in the tunnels.

The Report of the Campus Heating Committee[8] of the National District Heating Association in 1956, entitled "Tunnels versus Conduits" also describes the tunnel system at various institutions and discusses the relative merits of walk-through tunnels.

In addition to the letters to the universities, telegrams were sent out to Eielson Air Force Base, Fort Wainwright, and the Alaska District, Corps of Engineers, and a visit was made to the NASA Manned Spacecraft Center in Houston. Information on utility tunnels in the Los Angeles Civic Center and at the University of California, Irvine Campus, was provided D. L. Narver, Jr., of Holmes and

Narver. The University of California was the only university contacted which has accommodated flammable gas lines in their tunnel system, although this could be due, in part, to the small usage of gas at buildings other than the central heating facility. Information obtained from these sources is also summarized in this Appendix.

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE CORPORATION
NUCLEAR DIVISION

POST OFFICE BOX X
OAK RIDGE, TENNESSEE 37831

August 24, 1966

Director of the Physical Plant
University of Minnesota
Minneapolis, Minnesota

Dear Sir:

We are currently making a study on the use of underground tunnels for utilities. We would like to know if your university uses a system of this type. If so, what utilities, such as water, gas, power, etc. do you include.

Any information you can provide on this subject will be appreciated.

Sincerely yours,

W. J. Boegly, Jr.
Health Physics Division

WJB:jm

PHYSICAL PLANT AND
CAMPUS PLANNING

UNIVERSITY OF ALASKA

TO: Mr. W. L. Griffith
Union Carbide Corporation
Building 9704-2
P.O. Box Y
Oak Ridge, Tennessee 37830

DATE: 31 Oct. 66

Dear Mr. Griffith:

Enclosed are the documents you requested, one set of drawings and one set of specifications on the University of Alaska Utilidor System, 1963.

Please feel free to use this information as long as you wish, but please do return them to this office as they are part of our permanent records.

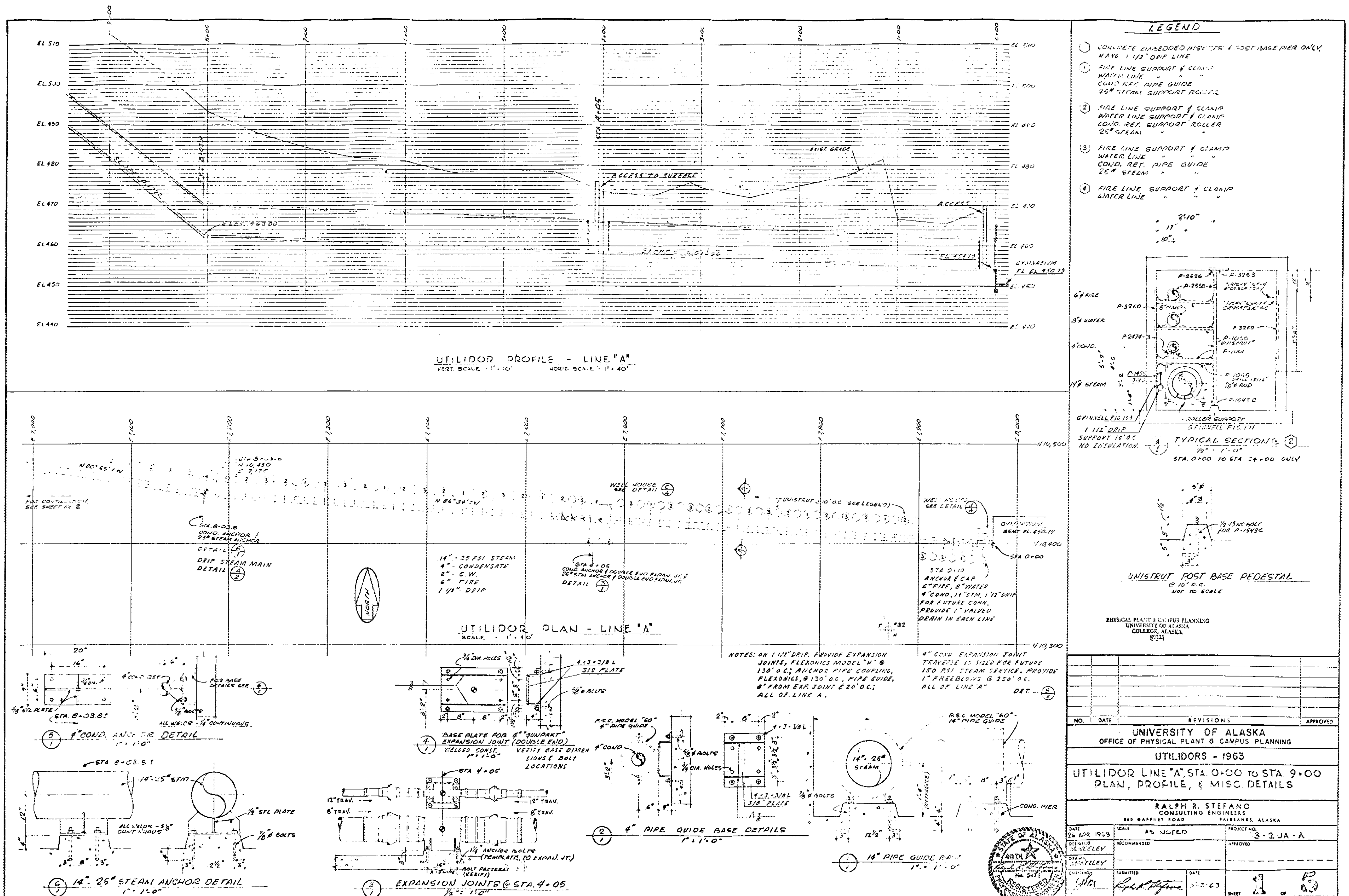
Norma H. Martin

(Mrs.) Norma H. Martin, Secretary

REPLY

nm

under sep. cover


UTILIDOR PROFILE - LINE "A"
VERT. SCALE - 1" = 10' HORIZ. SCALE - 1" = 40'
ACCESS TO SURFACE
EXIST. GRADE
ACCESS
GYMNASIUM
UTILIDOR PLAN - LINE "A"
SCALE - 1" = 40'
NORTH
14" - 25 PSI STEAM
4" - CONDENSATE
8" - C.W.
6" - FIRE
1 1/2" - DRIP
DRIP STEAM MAIN DETAIL
NOTES: ON 1 1/2" DRIP, PROVIDE EXPANSION JOINTS, FLEXONICS MODEL "H" @ 130' O.C.; ANCHOR PIPE COUPLING, FLEXONICS, @ 130' O.C., PIPE GUIDE, 8' FROM EXP. JOINT & 20' O.C.; ALL OF LINE A.
4" COND. EXPANSION JOINT TRAVERSE IS SIZED FOR FUTURE 150 PSI STEAM SERVICE. PROVIDE 1" FREEBLOWS @ 250' O.C. ALL OF LINE "A"
4" COND. ANCHOR DETAIL
BASE PLATE FOR 4" "GUNPART" EXPANSION JOINT (DOUBLE END)
4" PIPE GUIDE BASE DETAILS
14" PIPE GUIDE BASE
14" 25# STEAM ANCHOR DETAIL
EXPANSION JOINTS @ STA. 4+05
LEGEND
CONCRETE EMBEDDED INSERTS & POST BASE PIER ONLY, HANG 1 1/2" DRIP LINE
1 FIRE LINE SUPPORT & CLAMP
WATER LINE " " "
COND. RET. PIPE GUIDE
25# STEAM SUPPORT ROLLER
2 FIRE LINE SUPPORT & CLAMP
WATER LINE SUPPORT & CLAMP
COND. RET. SUPPORT ROLLER
25# STEAM " "
3 FIRE LINE SUPPORT & CLAMP
WATER LINE " " "
COND. RET. PIPE GUIDE
25# STEAM " "
4 FIRE LINE SUPPORT & CLAMP
WATER LINE " " "
TYPICAL SECTION 2
STA. 0+00 TO STA. 24+00 ONLY
UNISTRUT POST BASE PEDESTAL
@ 10' O.C.
NOT TO SCALE
PHYSICAL PLANT & CAMPUS PLANNING
UNIVERSITY OF ALASKA
COLLEGE, ALASKA
NO. DATE REVISIONS APPROVED
UNIVERSITY OF ALASKA
OFFICE OF PHYSICAL PLANT & CAMPUS PLANNING
UTILIDORS - 1963
UTILIDOR LINE "A", STA. 0+00 TO STA. 9+00
PLAN, PROFILE, & MISC. DETAILS
RALPH R. STEFANO
CONSULTING ENGINEERS
FAIRBANKS, ALASKA
DATE 26 APR 1963
SCALE AS NOTED
PROJECT NO. 3-2 UA-A
DESIGNED
DRAWN
RECOMMENDED
APPROVED
CHECKED
SUBMITTED
DATE 5-2-63
SHEET 1 OF 63

THE UNIVERSITY OF ARIZONA
TUCSON

PHYSICAL PLANT
OFFICE OF THE DIRECTOR

August 30, 1966

Mr. W. J. Boegly, Jr.
Health Physics Division
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37831

Dear Mr. Boegly:

Reference your letter of August 24, 1966, regarding the use of underground tunnels for utilities.

The University of Arizona has a system of underground utility tunnels that radiate from a central heating and refrigeration plant, and electrical sub-station. We are enclosing a couple of copies of a typical cross section of one of our tunnels so as to give you an idea of piping arrangements. Tunnels vary in size from the smallest, 2' wide and 3' high crawl tunnels used as branches to various small buildings, to 7' high by 9' wide main tunnels emerging from the central plant. These tunnels are all formed reinforced concrete construction and contain domestic water, chilled water for refrigeration and cooling, steam and condensate lines, electricity, communications wiring, clock and class bell wiring, and control systems. In fact all utilities are run in these tunnels with the exception of gas and domestic sewer lines for obvious reasons.

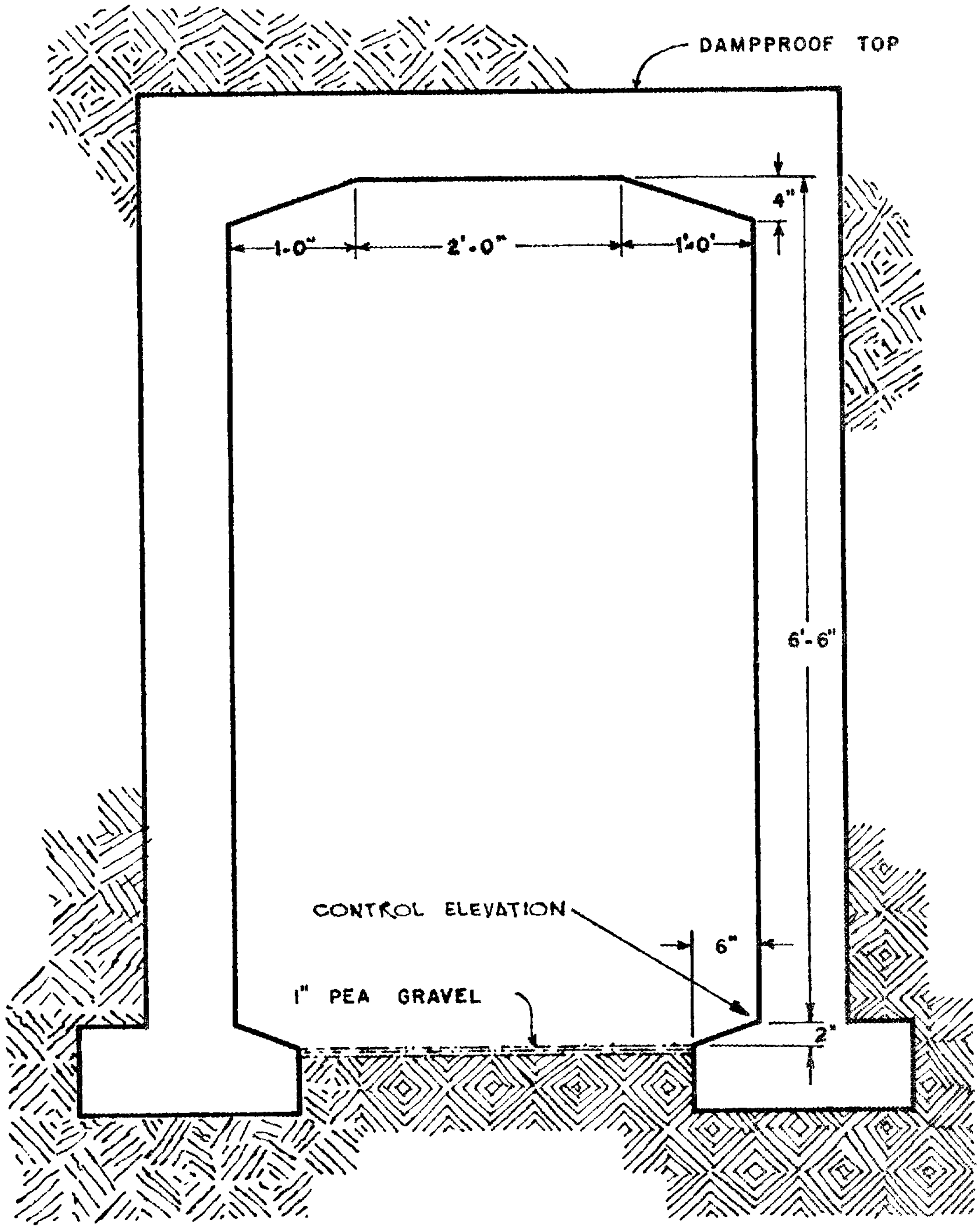
Most of these tunnels are graded so that gravity condensate lines are usable and so that the tunnels are not buried to excessive depths. The tops of all tunnels are waterproofed and vary from 3' to 10' underground.

We hope that this information will be of value to you. If you have any further questions, do not hesitate to ask.

Very truly yours,

Robert L. Houston
Director of Physical Plant

RLH:jb



UNIVERSITY *of* ARIZONA

A TYPICAL 4'-0" UTILITY TUNNEL SECTION

MEMORANDUM OF CONFERENCE OR CONVERSATION

DATE: October 28, 1966

TIME:

[X] TELEPHONE [ ] PERSONAL

ORIGINATING PARTY	OTHER PARTIES
W. L. Griffith	Caroll Waite
W. J. Boegly, Jr.	University of Southern California
	Los Angeles, California

SUBJECT:

Utility Tunnels at the University of Southern California

DISCUSSION:

The University of Southern California does not use underground tunnels on its campus.

CONCLUSION OR AGREEMENTS

DISTRIBUTION:

SIGNED

UCN-693
(123 7-59)

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE ACADEMY
USAF ACADEMY, COLORADO 80840

REPLY TO
ATTN OF: DEC

29 SEP 1966

SUBJECT:

TO: Mr. W.J. Boegly, Jr.
Health Physics Division
Oak Ridge National Laboratory
Post Office Box X
Oak Ridge, Tennessee 37831

Dear Mr. Boegly:

In reply to your letter of 24 August 1966 regarding the use of underground tunnels for utility distribution systems, tunnels are used for connecting all main buildings at the United States Air Force Academy. Our primary distribution system for water, high-temperature hot-water, secondary electrical system and communication systems are housed within the tunnel system. Primary electrical distribution systems and gas are not included.

We hope this information can be of some help to you. If we can be of any further assistance, please do not hesitate to let us know.

Sincerely,

JOHN W. McDONALD, JR., Major, USAF
Director/Control Center

"MAN'S FLIGHT THROUGH LIFE IS SUSTAINED BY THE POWER OF HIS KNOWLEDGE"

CITY AND COUNTY OF DENVER

DEPARTMENT OF PUBLIC WORKS

September 26, 1966

OFFICE OF THE MANAGER
CITY AND COUNTY
BUILDING
DENVER, COLORADO 80202

Oak Ridge National Laboratory
Post Office Box X
Oak Ridge, Tennessee 37831

Attention: W. J. Beogly, Jr.
Health Physics Division

Gentlemen:

Reference is made to your letter of September 20, 1966 regarding underground utility tunnels.

Denver has no underground utility tunnels as a part of its utility system.

The six State Capitol buildings have approximately 1300 feet of tunnels containing water, steam, power, and communication lines. The City and County of Denver has approximately 600 feet of tunnels connecting three of its buildings. These tunnels contain steam, gas, and water lines.

It is a pleasure to be of service to you.

Very truly yours,

W. H. McNichols, Jr.
Manager of Public Works

JES/f

CITY AND COUNTY OF DENVER

DEPARTMENT OF PUBLIC WORKS

October 7, 1966

OFFICE OF THE MANAGER
CITY AND COUNTY
BUILDING
DENVER, COLORADO 80202

Oak Ridge National Laboratory
Post Office Box X
Oak Ridge, Tennessee 37831

Attention: W. J. Beogly, Jr.
Health Physics Division

Gentlemen:

In reply to your telephone call of October 6, 1966 regarding several specific questions in relation to gas lines located in underground utility tunnels, we are enclosing a print showing a utility tunnel which connects two municipal buildings.

No provisions were made for ventilation except by natural means.

For information on utility tunnels maintained by the State of Colorado, please contact

Mr. Thomas C. Nichols
State Services Building, Room 712
1525 Sherman Street
Denver, Colorado 80203
or
Phone 222-9911, Ext. 2161.

We trust that this will be of interest to you.

Very truly yours,

W. H. McNichols, Jr.
Manager of Public Works

JES/f

University of Miami
Box 8067
Coral Gables, Florida
August 31, 1966

W. J. Boegly, Jr.
Oak Ridge National Laboratory
Post Office Box X
Oak Ridge, Tennessee

Dear Sir:

We do not utilize the tunnel system for utilities at the University of Miami due to our low water table. Two Universities in Florida that do utilize tunnels are, Atlantic University in Boca Raton and the University of South Florida in Tampa.

These two Universities are both new and the tunnels were laid out in their preplanning stage of construction.

If you will write to the Physical Plant Director of these Universities, I am sure they will give you any information you desire.

Sincerely,

E. Hart Morris
Resident Engineer

EHM:lw

FLORIDA ATLANTIC UNIVERSITY

BOCA RATON, FLORIDA

33432

#66-254

September 12, 1966

Mr. W. L. Griffith, Process Analysis
Union Carbide Corporation
Nuclear Division
P. O. Box Y
Oak Ridge, Tennessee 37831

Dear Mr. Griffith:

With reference to your letter of September 7th, we are pleased to advise that Florida Atlantic University's Physical Plant operates from a central utility facility.

Utilities listed below are distributed through underground concrete trenches which average approximately 20 feet in width and 6' 3" in height. The top is covered with concrete walks:

Air Conditioning - Chilled Lines

A central two pipe chilled water system (centrally controlled in our Utilities Building

Heating - Hot Water Pipes

A central two pipe medium temperature hot water system (centrally controlled in our Utilities Building

Irrigation Water Lines

6" water main for irrigation. Domestic use not included

Electric Power

13,200 volts and 4,160 volts furnished at Utilities Building. Distribution lines utilizing 13,200 volts carried on racks in trenches.

-continued-

Communication Lines

Telephone, Pre-signal Fire Alarm, Electronic Clock Program lines carried on racks in trenches.

Educational TV Distribution Lines

Distribution lines are run in trench from a central TV Production Center, whenever appropriate

I hope the above information will be helpful to your study. Please let us know if we can be of further assistance.

Very truly yours,

FLORIDA ATLANTIC UNIVERSITY

Fred H. Gardner
Director of Plant Operations

FHG:mc

UNIVERSITY OF SOUTH FLORIDA
TAMPA, FLORIDA 33620
AREA CODE 813: 988-4131

DIVISION OF THE PHYSICAL PLANT

September 9, 1966

Mr. W. L. Griffith
Process Analysis
Union Carbide Corporation
Nuclear Division
P. O. Box Y
Oak Ridge, Tennessee 37831

Dear Mr. Griffith:

We do not use a tunnel system; however, Florida Atlantic University at Boca Raton, Florida, does use this type of system. Mr. Fred Gardner is the Director of Physical Plant, and I feel sure he would be happy to give you any information that he has available.

Sincerely,

Clyde B. Hill

Clyde B. Hill, Director
Physical Plant Division

CBH/mjh

GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA 30332

PHYSICAL PLANT DEPARTMENT
OFFICE OF THE DIRECTOR

September 1, 1966

Mr. W. J. Boegly, Jr.
Health Physics Division
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37831

Dear Mr. Boegly:

I have your letter of August 24, 1966 concerning the use of underground tunnels for utilities. Although we have no underground tunnels at present, we are just completing final plans and specifications for a new utilities distribution system to a new section of the campus. This new utilities distribution system will consist of 16" diameter high temperature hot water heating lines, 24" diameter chilled water lines and electrical conduit.

After considerable analysis and investigation of actual installations, we have decided to place the two HTHW mains in a concrete trench. This trench will be approximately four feet deep and eight feet wide, interior dimensions, and will be covered by pre-fabricated roof slabs which can be easily removed. The tunnel system will actually form a sidewalk as it will follow the surface of the ground. We feel that the trench will be as satisfactory as a walk-through tunnel, while much less expensive. This same system is presently in use at the Kennedy International Airport. The electrical conduit bank will be placed along side the tunnel in the same cut. The chilled water lines will be direct buried along side the HTHW trench.

If you are interested further in this arrangement, final plans and specifications will be available in approximately four weeks. If you prepare a copy of your study for distribution, I would very much appreciate receiving a copy.

Yours very truly,

P. G. Rector
Director

PGR/ml

PURDUE UNIVERSITY
DEPARTMENT OF PHYSICAL PLANT
LAFAYETTE, INDIANA 47907

September 1, 1966

Oak Ridge National Laboratory
Post Office Box X
Oak Ridge, Tennessee 37831

Attention: Mr. W. J. Boegly, Jr.

Gentlemen:

Your letter of August 24, 1966 with reference to underground tunnels for utilities has been referred to the writer for reply.

Purdue University uses a concrete tunnel system for the distribution of certain utility services to the main campus buildings.

In the original tunnel system started some thirty years ago, the tunnel carried high and low pressure steam, condensate return, control air, 2400 volt electric service, telephone and water services. With the campus expansion in progress, water and electric distribution lines are being removed from the old tunnels. Water distribution is installed in Ductile Iron pipe underground and electric distribution at 12,500 volts in concrete ducts underground.

All the new main tunnel system is 6'-8" by 6'-8" concrete construction and carries high and low pressure steam, condensate return, telephone, TV cable and control air. No gas lines are permitted in the tunnels. Where a gas line crosses a main tunnel, it is installed in a steel or cast iron pipe sleeve as a safety measure. The system now comprises more than 12 miles of concrete tunnel. All chilled water service lines are buried in the ground.

We would be pleased to have you visit this campus and inspect the tunnel system.

Very truly yours,

N. D. Miller
N. D. Miller
Supt. of Utilities

NDM/gj

INDIANA
1816–1966

MEMORANDUM OF CONFERENCE OR CONVERSATION

DATE: November 2, 1966 | TIME: | [X] TELEPHONE [ ] PERSONAL

ORIGINATING PARTY	OTHER PARTIES
W. L. Griffith	Mr. N. D. Miller
W. J. Boegly, Jr.	Superintendent of Utilities
	Purdue University, Lafayette, Indiana

SUBJECT: Additional Information about Utility Tunnels at Purdue

DISCUSSION:

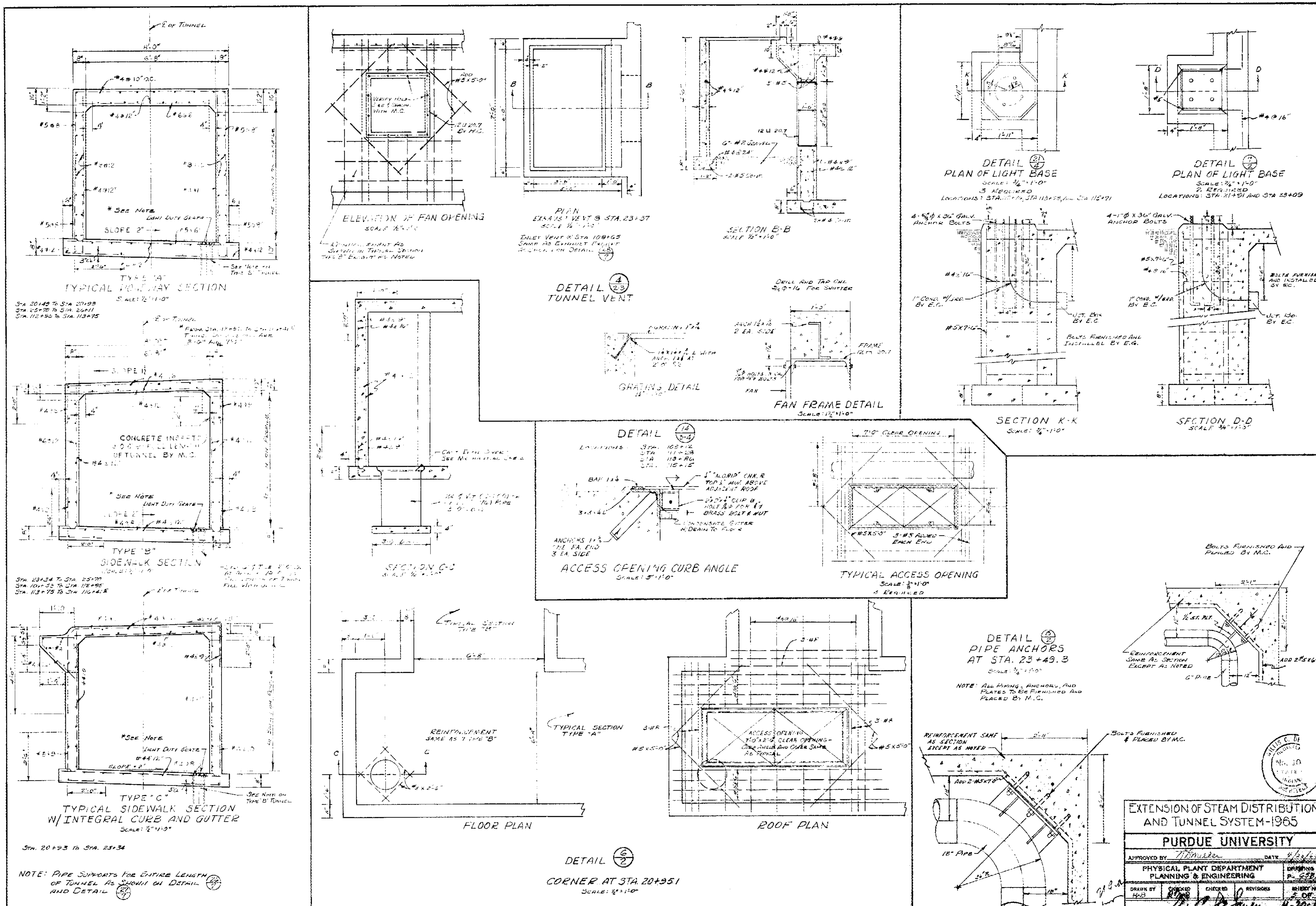
Mr. Miller said that water lines in the old tunnels were steel pipes and were badly corroded. Thus, when extra space was needed they decided to use cast iron pipe and burial outside the tunnel where they could better anchor bends, etc. He also indicated a concern about increases in water temperature due to heat loss from steam lines. Power cables are also excluded from the tunnels for this reason.

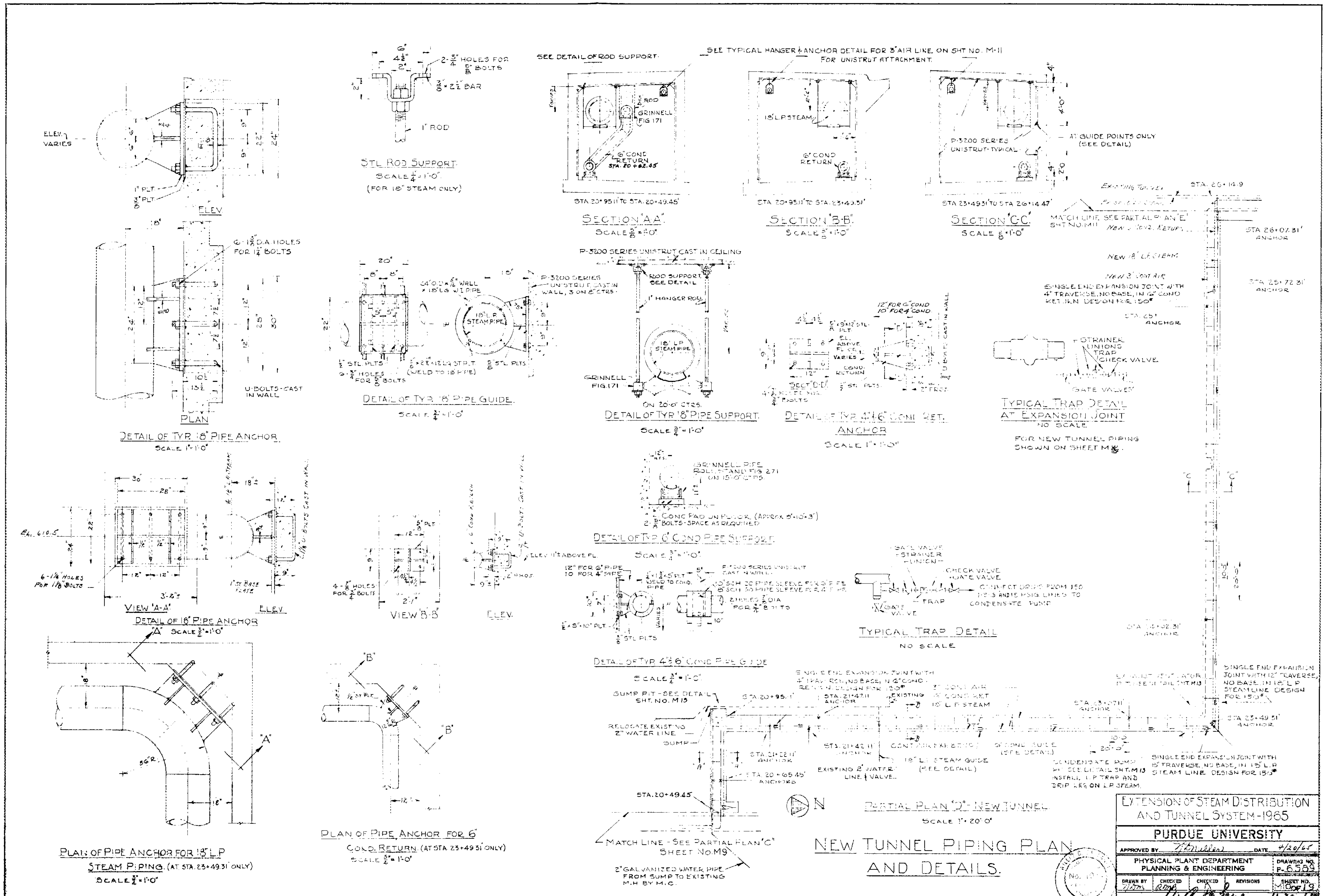
The tops of the tunnels at Purdue serve as sidewalks. He promised to send typical cross-section drawings for our use.

CONCLUSION OR AGREEMENTS

DISTRIBUTION: | SIGNED

UCN-693
(123 7-59)


TYPE "A"
TYPICAL ROADWAY SECTION
TYPE "B"
SIDEWALK SECTION
TYPE "C"
TYPICAL SIDEWALK SECTION
W/ INTEGRAL CURB AND GUTTER
ELEVATION OF FAN OPENING
SECTION B-B
DETAIL
TUNNEL VENT
GRATING DETAIL
FAN FRAME DETAIL
SECTION C-C
ACCESS OPENING CURB ANGLE
TYPICAL ACCESS OPENING
DETAIL
PLAN OF LIGHT BASE
SECTION K-K
SECTION D-D
DETAIL
PIPE ANCHORS
AT STA. 23+49.3
FLOOR PLAN
ROOF PLAN
DETAIL
CORNER AT STA. 20+95.1
EXTENSION OF STEAM DISTRIBUTION
AND TUNNEL SYSTEM-1965
PURDUE UNIVERSITY
PHYSICAL PLANT DEPARTMENT
PLANNING & ENGINEERING



SEE DETAIL OF ROD SUPPORT
SEE TYPICAL HANGER & ANCHOR DETAIL FOR 3" AIR LINE ON SHT NO. M-11 FOR UNISTRUT ATTACHMENT.
ELEV. VARIES
ELEV
STL. ROD SUPPORT
SCALE 3/4"=1'-0"
(FOR 18" STEAM ONLY)
1" ROD
GRINNELL FIG 171
6" COND RETURN
STA. 20+95.11' TO STA. 20+49.45'
SECTION "A-A"
18" L.P. STEAM
6" COND RETURN
STA. 20+95.11' TO STA. 23+49.31'
SECTION "B-B"
P-3200 SERIES UNISTRUT-TYPICAL
AT GUIDE POINTS ONLY (SEE DETAIL)
STA. 23+49.31' TO STA. 26+14.47'
SECTION "C-C"
MATCH LINE - SEE PARTIAL PLAN "E" SHT NO. M11
STA. 26+14.9
STA. 26+07.81' ANCHOR
STA. 25+72.81' ANCHOR
NEW 18" L.P. STEAM
NEW 3" VENT AIR
SINGLE END EXPANSION JOINT WITH 4" TRAVERSE, NO BASE, IN 6" COND RETURN DESIGN FOR 150#
STA. 25' ANCHOR
6-1 3/8" DIA HOLES FOR 1 1/4" BOLTS
U-BOLTS-CAST IN WALL
PLAN
DETAIL OF TYP. 18" PIPE ANCHOR
SCALE 1"=1'-0"
P-3200 SERIES UNISTRUT CAST IN CEILING
ROD SUPPORT SEE DETAIL
1" HANGER ROD
18" L.P. STEAM PIPE
GRINNELL FIG 171
ON 20'-0" CTRS.
DETAIL OF TYP. 18" PIPE SUPPORT
SCALE 3/4"=1'-0"
P-3200 SERIES UNISTRUT CAST IN WALL, 3 ON 6" CTRS.
18" L.P. STEAM PIPE
DETAIL OF TYP. 18" PIPE GUIDE
SCALE 3/4"=1'-0"
12" FOR 6" COND 10" FOR 4" COND
COND RETURN
SECT "D-D"
DETAIL OF TYP. 4" & 6" COND RET. ANCHOR
SCALE 1"=1'-0"
STRAINER
UNIONS
TRAP
CHECK VALVE
GATE VALVES
TYPICAL TRAP DETAIL AT EXPANSION JOINT
NO SCALE
FOR NEW TUNNEL PIPING SHOWN ON SHEET M-
GRINNELL PIPE ROLL STAND FIG 271 ON 15'-0" CTRS.
CONC PAD ON FLOOR (APPROX 8"x10"x3")
DETAIL OF TYP. 6" COND PIPE SUPPORT
VIEW "A-A"
ELEV
DETAIL OF 18" PIPE ANCHOR
"A" SCALE 3/4"=1'-0"
6-1 1/4" HOLES FOR 1 1/8" BOLTS
4-3/4" HOLES FOR 5/8" BOLTS
VIEW "B-B"
ELEV.
DETAIL OF TYP. 4" & 6" COND PIPE GUIDE
SCALE 3/4"=1'-0"
GATE VALVE
STRAINER
UNION
CHECK VALVE
GATE VALVE
TRAP
CONNECT DRIP FROM 150 LBS & AND 15 PSIG LINES TO CONDENSATE PUMP
TYPICAL TRAP DETAIL
NO SCALE
SINGLE END EXPANSION JOINT WITH 12" TRAVERSE, NO BASE, IN 18" L.P. STEAM LINE DESIGN FOR 15#
STA. 23+49.31' ANCHOR
SUMP PIT - SEE DETAIL SHT. NO. M13
RELOCATE EXISTING 2" WATER LINE
SUMP
STA. 20+95.11'
STA. 21+47.11' ANCHOR
EXISTING 3" CONC AIR
EXISTING 18" L.P. STEAM
EXISTING 2" WATER LINE & VALVE
18" L.P. STEAM GUIDE (SEE DETAIL)
STA. 20+65.45' ANCHOR
STA. 20+49.45'
CONDENSATE PUMP - SEE DETAIL SHT. M13 INSTALL L.P. TRAP AND DRIP LEG ON L.P. STEAM
SINGLE END EXPANSION JOINT WITH 18" TRAVERSE, NO BASE, IN 18" L.P. STEAM LINE DESIGN FOR 15#
PARTIAL PLAN "D" - NEW TUNNEL
SCALE 1"=20'-0"
MATCH LINE - SEE PARTIAL PLAN "C" SHEET NO. M9
2" GALVANIZED WATER PIPE FROM SUMP TO EXISTING M.H. BY M.C.
"A"
"B"
PLAN OF PIPE ANCHOR FOR 18" L.P. STEAM PIPING. (AT STA. 23+49.31' ONLY)
SCALE 3/4"=1'-0"
PLAN OF PIPE ANCHOR FOR 6" COND. RETURN. (AT STA 23+49.31' ONLY)
SCALE 3/4"=1'-0"
NEW TUNNEL PIPING PLAN AND DETAILS.
EXTENSION OF STEAM DISTRIBUTION AND TUNNEL SYSTEM-1965
PURDUE UNIVERSITY
APPROVED BY
DATE 4/20/65
PHYSICAL PLANT DEPARTMENT PLANNING & ENGINEERING
DRAWING NO. P-6589
DRAWN BY
CHECKED
REVISIONS
SHEET NO. M10 OF 19
CERTIFIED BY
DATE 4-20-65

UNITED STATES NAVAL ACADEMY
Annapolis, Maryland—21402

IN REPLY REFER TO:

27 September 1966

Oak Ridge National Laboratory
Post Office Box X
Oak Ridge, Tennessee 37831

Attn: Mr. W. J. Boegly, Jr.
Health Physics Division

Gentlemen:

The utilities systems here at the Naval Academy are installed in several underground tunnels but in the main in utility trenches. We have two tunnels both of which are at elevations above the area where ground water is a problem. And these contain steam, water, air and power.

Our main problem here on the Severn River is the ever present hazard of the flooding of our smaller utility trenches by river water. These trenches containing principally steam and condensate distribution lines are frequently flooded during periods of high water resulting from storms. This creates a high rate of steam loss to the condensation of the steam when the lines are even partially submerged in water.

In the overall rehabilitation that is now underway here, we are planning the construction of additional walking tunnels for the transmission of the utilities mentioned above as well as chilled water for air conditioning operations. These tunnels are planned to permit more effective drainage and pumping by means of steam ejectors or motor driven pumps located in the sumps.

A new high temperature, high pressure, hot water heating plant is planned for installation within the next several years to replace our present steam distribution system. The new heating plant will be in another location from the present steam generating plant and the hot water will be direct buried and supply lines of the Ric-wil type as approved by the Department of Defense for low area installations adjacent to a body of water. These will be located through areas other than the existing proposed tunnels referred to above. These tunnels will however cover a portion of the total length of these runs.

You may call upon us for any information desired.

Very truly yours,

A. B. Williams

A. B. WILLIAMS
Director, Engineering Division
Public Works Department

MICHIGAN STATE UNIVERSITY EAST LANSING · MICHIGAN 48823

PHYSICAL PLANT DIVISION · PHYSICAL PLANT BUILDING

August 31, 1966

Mr. W. J. Boegly, Jr.
Health Physics Division
Oak Ridge National Laboratory
Post Office Box X
Oak Ridge, Tennessee 37831

Re: Underground Tunnels for Utilities

Dear Mr. Boegly:

In response to your letter of August 24, 1966, we are enclosing typical sketches of our steam tunnels.

We use walk-through tunnels for our main steam and return line extensions. We also use walk-through tunnels for the building service runs, whenever the building may have future requirements for underground piping. We have installed chilled water piping in these tunnels when a connection between buildings is necessary to utilize one chilled water source for air conditioning. We have also installed demineralized water lines between our power plants in these tunnels.

We do not run domestic water through the steam tunnels because it would raise the water temperature. The natural gas company, Consumers Power Company, is opposed to having gas lines run in tunnels because of the great safety hazard due to possible leaks.

Electric power cables are not installed in these tunnels, since their carrying capacity is greatly affected by a rise in temperature.

We have found that the underground tunnel is no more expensive than a high quality buried steam and return system, when large pipes (18" steam, 10" return) are being used. The reduced maintenance costs and future pipe space which are obtained by the use of a tunnel more than off-set the additional cost on a building service, when this building is a type which will need future piping.

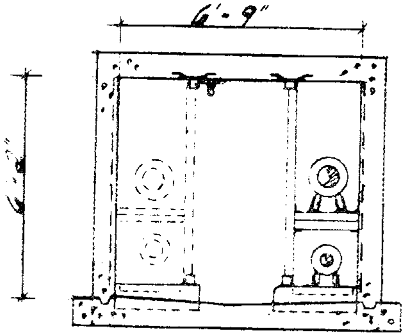
If we can be of further help to you, please contact us.

Very truly yours,

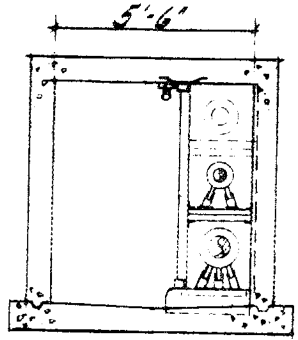
T. B. Simon

T. B Simon
Director

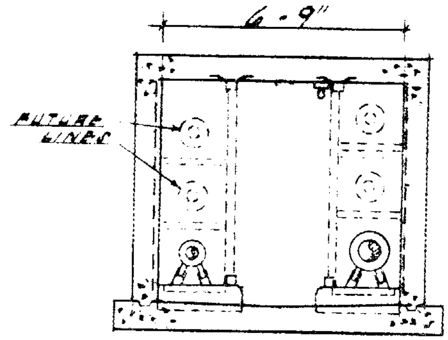
c.c. R. T. Flinn



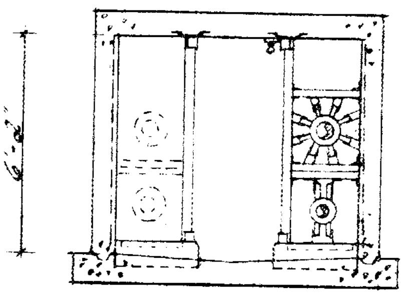
TYPE "A"



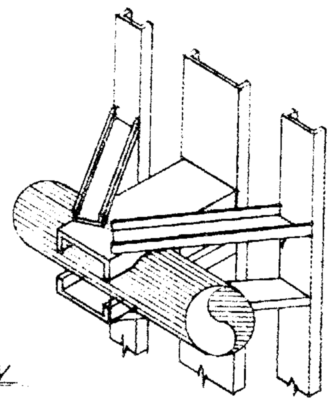
TYPE "B"



TYPE "C"



TYPICAL "A" SECTION AT PIPE GUIDES



TYPICAL TUNNEL ANCHOR

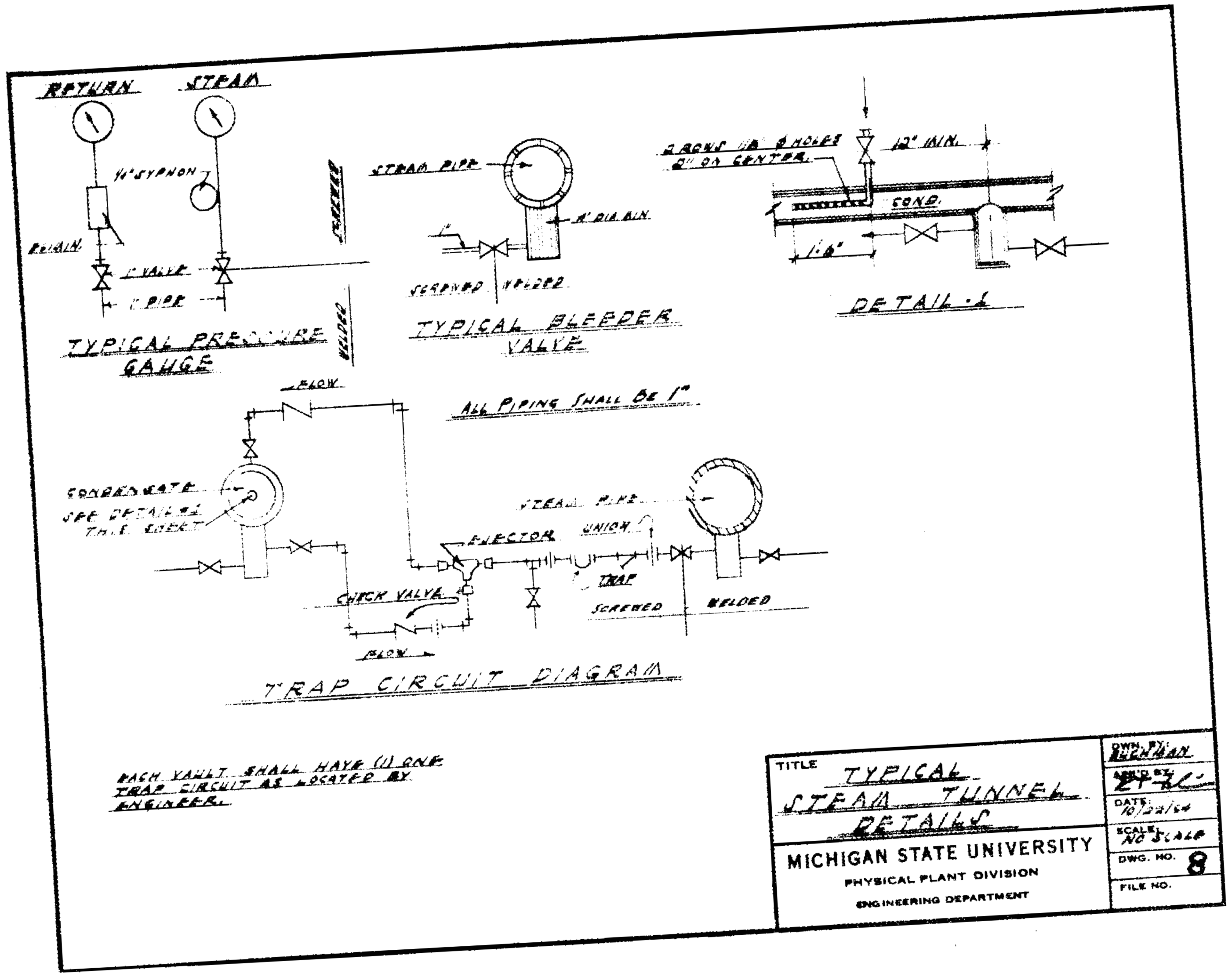
STRUCTURAL DESIGN

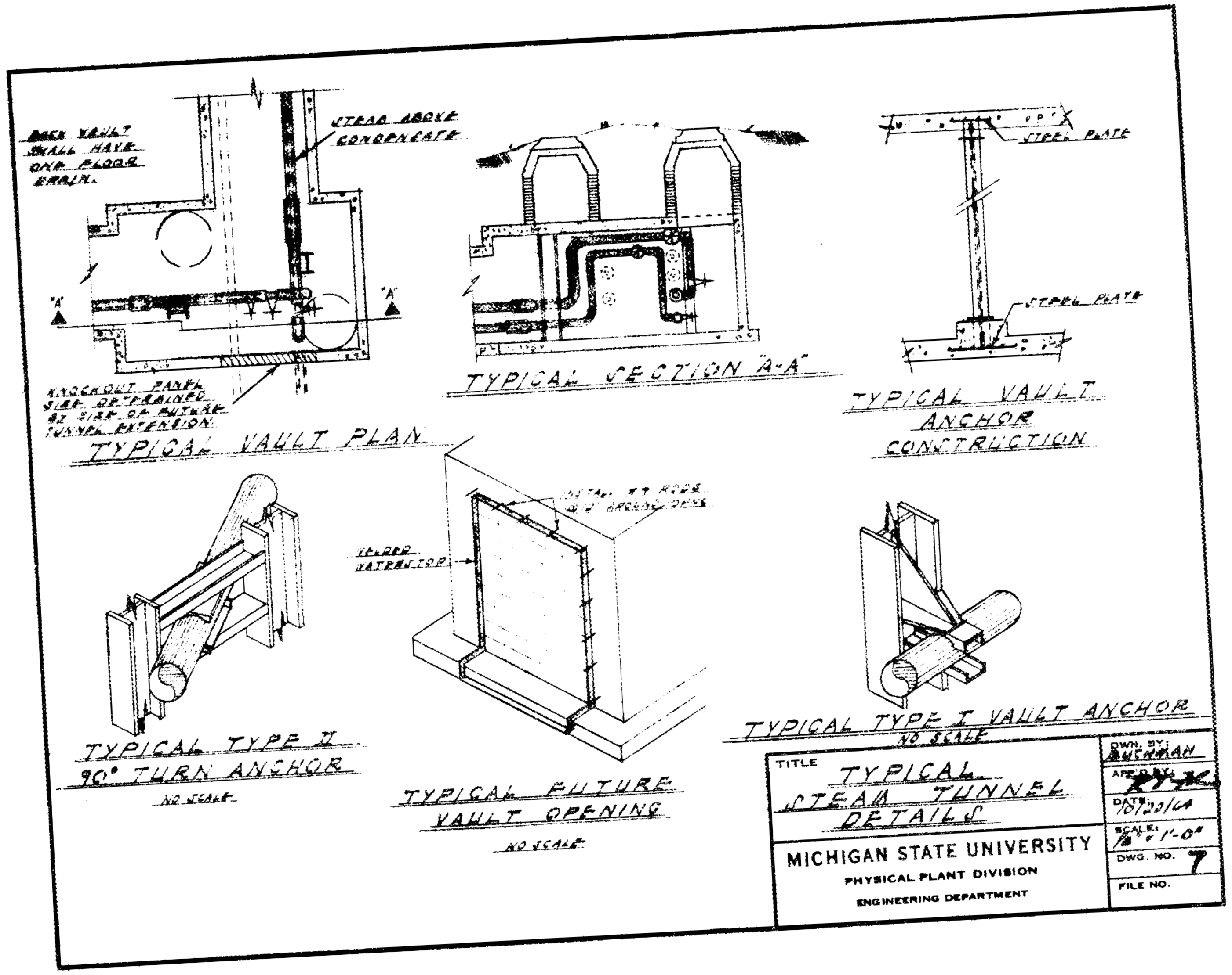
8' OF EARTH FILL OR 5' OF EARTH FILL + TRUCK SURCHARGE.

CONCRETE - 3000 PSI

STEEL - 24,000 P.S.I. A432

TITLE TYPICAL STEAM TUNNEL DETAILS	DWN. BY: BUCHAAN
	APP'D BY:
	DATE: 10/23/64
MICHIGAN STATE UNIVERSITY PHYSICAL PLANT DIVISION ENGINEERING DEPARTMENT	SCALE:
	DWG. NO. 6
	FILE NO.


RETURN
STEAM
TYPICAL PRESSURE GAUGE
STEAM PIPE
TYPICAL BLEEDER VALVE
DETAIL-1
ALL PIPING SHALL BE 1"
CONDENSATE
STEAM PIPE
EJECTOR
UNION
CHECK VALVE
TRAP
SCREWED
WELDED
FLOW
TRAP CIRCUIT DIAGRAM
EACH VAULT SHALL HAVE (1) ONE TRAP CIRCUIT AS LOCATED BY ENGINEER.
TITLE
TYPICAL STEAM TUNNEL DETAILS
MICHIGAN STATE UNIVERSITY
PHYSICAL PLANT DIVISION
ENGINEERING DEPARTMENT
DATE: 10/22/64
SCALE: NO SCALE
DWG. NO. 8
FILE NO.


EACH VAULT SHALL HAVE ONE FLOOR DRAIN.
STEAM ABOVE CONDENSATE
TYPICAL VAULT PLAN
TYPICAL SECTION "A-A"
STEEL PLATE
TYPICAL VAULT ANCHOR CONSTRUCTION
TYPICAL TYPE II 90° TURN ANCHOR
NO SCALE
TYPICAL FUTURE VAULT OPENING
NO SCALE
TYPICAL TYPE I VAULT ANCHOR
NO SCALE
TITLE
TYPICAL STEAM TUNNEL DETAILS
MICHIGAN STATE UNIVERSITY
PHYSICAL PLANT DIVISION
ENGINEERING DEPARTMENT
DWG. NO. 7
FILE NO.

UNIVERSITY OF *Minnesota*

PLANT SERVICES • MINNEAPOLIS, MINNESOTA 55455

October 18, 1966

Mr. W. J. Boegly, Jr.
Health Physics Division
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37831

Re: Underground Tunnels from Your
Request, By Letter, Dated 8/26/66

Dear Sir:

I have been requested by Mr. Christensen, of the City of Minneapolis Sewer Division, to confer to you the University of Minnesota's extensive underground tunnel system. The University has an ideal location for a system of tunnels. These tunnel systems are used for sanitary, storm and heating tunnels. The nature of our soil strata is a layer of about 45 feet of overburden. Under this overburden is a 35 feet thick layer of solid Platteville limestone and beneath the limestone we have a very deep layer of St. Peter sandstone.

Our heating tunnel serves several purposes as steam mains, condensate return lines, electric lines, air lines, telephone lines and chilled water lines for air conditioning. We construct shafts from this lower sandstone layer up through the limestone to the surface of the ground and serve each building with a surface stub tunnel from this shaft. Our tunnels are concrete lined with uni-strut inserts every 9 feet on center and anchor plates embedded in the concrete walls in order to hold the expansion points of the steam main lines in position. We have several miles of tunnels throughout our campus. Uni-struts are built for the purpose of holding pipes in pipe racks.

Our St. Paul Campus tunnel system is a surface tunnel system, not over 25 feet in depth, but serves the same type of utilities. Our heating plants are located at a lower elevation so that we can have gravity return our condensate line. We have 200 lb. steam pressure lines and reduce them at the buildings to 125 lbs. and from there we have a hot water baseboard heating system in the building to heat the actual building.

UNIVERSITY OF *Minnesota*

PLANT SERVICES · MINNEAPOLIS, MINNESOTA 55455

Mr. W. J. Boegly, Jr.
October 18, 1966
Page Two

Our heating tunnels are from 5 to 7 feet inside diameter in width and approximately 7 feet in height. The shafts, which go from the lower level up to the surface, are approximately 5 feet in diameter. Our storm and sanitary sewer systems are approximately 2½ to 3 feet in width and 6½ to 7 feet in height and they are all concrete lined. Several places we have only a drill hole from the surface of the ground drilled down into this lower sandstone layer to have the sewage drop from the surface level down into our deep tunnel system.

I hope I have been of some help to you in relating to you the nature of our tunnels and the systems in which they work, and if I can be of any further help, please feel free to write for more details.

Very truly yours,

O. J. Nelson

O. J. Nelson, P. E.
Asst. Supervising Engineer
Plant Services
University of Minnesota

OJN:mep

University of Missouri
COLUMBIA - KANSAS CITY - ROLLA - ST LOUIS

OFFICE OF DIRECTOR OF PHYSICAL PLANT

110 General Services
Columbia, Mo. 65201
Area 314 - 449-9101

September 7, 1966

Mr. W.J. Boegly, Jr.
Oakridge National Laboratory
Union Carbide Corp.
Building 3504 P.O. Box X
Oakridge, Tenn. 37831

Dear Mr. Boegly:

I write in reply to your letter of August 22, 1966, in which you indicated you were interested in underground tunnels for utilities.

We have many of our steam and return lines in walk-through tunnels. These tunnels were constructed approximately 40 years ago and are still in good condition. They are mainly brick construction. Formerly, electric distribution was handled in this same tunnel, however, due to the growth of our campus, electric distribution systems have been removed from the steam tunnel. I would not recommend that electric distribution systems be handled in the same tunnel with heating pipes. The temperature is usually high in the tunnel and reduces the carrying capacity of electric cables.

The cost of constructing tunnels has been such that it has not been possible for the University to extend it's walk-through tunnels. We are now using concrete chases for distribution of steam and return lines.

Water lines are buried directly in the ground. Gas lines are directly in the ground with electric power being distributed underground in conduit encased in red tinted concrete.

The most satisfactory system of which I know, is at the University of Oaklahoma at Norman, Oaklahoma. I understand they distribute steam, have condensate return as well as chilled water lines, gas lines, and power lines in their utility tunnels. The tunnels are well ventilated and are quite satisfactory for their use. I would suggest you contact the Director of the Physical Plant at the University of Oaklahoma for further information regarding this matter.

Hope this information will be of some value to you in your study.

Very truly yours,

Raymond Halbert
Director of the
Physical Plant

RH/bjl

CORNELL UNIVERSITY
DEPARTMENT OF BUILDINGS AND PROPERTIES
ITHACA, NEW YORK

September 9, 1966

Mr. W. J. Boegly, Jr.
Health Physics Division
Oak Ridge National Laboratory
P.O. Box X
Oak Ridge, Tennessee 37831

Dear Mr. Boegly:

In answer to your letter of August 24 I shall have to advise that Cornell does not use underground tunnels for utilities except in rare instances where conditions make their use imperative. All our utilities are now direct burial, including steam, water, power, sewers, chilled water, etc. I have regretted many times that our utilities are not in tunnels for maintaining them would be much easier. However, the University started on direct burial in 1929 and to make changes now would not be justified.

Where we do use short sections of tunnel, we have put into them all the utilities that were in the area and we now have a section of tunnel in which there is steam, chilled water and electricity.

Very sincerely yours,

Julius F. Weinhold
Director of Physical Plant

JFW:md

Please Address Reply to the Department and Not to an Individual

DEPARTMENT OF THE ARMY
UNITED STATES MILITARY ACADEMY
WEST POINT, NEW YORK 10996
OFFICE OF THE ENGINEER

MAEN-A

2 September 1966

Mr. W. J. Boegly Jr.
Health Physics Division
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37830

Dear Sir:

Your letter of 24 August 1966 sent to the Dean of the United States Military Academy requesting information on the use of underground utility tunnels at the Military Academy has been referred to this office for reply.

Underground utility tunnels, as such, are not used extensively at this installation because rock excavation would have been required for their installation. Only a small portion of our steam distribution system located in the core area is installed in a "walk-thru" tunnel. The underground electrical distribution system is installed in a manhole-duct system while water and gas are distributed by direct buried pipes.

If I can be of further assistance, please do not hesitate to contact me.

Sincerely yours,

RIEL S. CRANDALL
Colonel, CE
Engineer

MEMORANDUM OF CONFERENCE OR CONVERSATION

DATE: September 12, 1966

TIME:

[X] TELEPHONE [ ] PERSONAL

ORIGINATING PARTY	OTHER PARTIES
W. L. Griffith	J. Kuhlman
	University of Oklahoma
	Norman, Oklahoma

SUBJECT: Underground Utility Tunnel System at the University of Oklahoma

DISCUSSION:

Mr. J. Kuhlman explained that some of the utility tunnels built 20 years ago were too small. The utilities in the tunnels include steam, chilled water, associated returns, potable water, compressed air, and electric power. No fuel gas is run in the tunnels. This is due at least in part to the small requirements for laboratories, etc.

Some tunnels are built under sidewalks to save snow removal. Main tunnel is 10' x 10', and the average size is 4-1/2 x 6-1/2 feet. There are about 4-1/2 miles of tunnels.

CONCLUSION OR AGREEMENTS

DISTRIBUTION:

SIGNED

UCN-693
(123 7-59)

UNIVERSITY OF OREGON

DEPARTMENT OF PHYSICAL PLANT

EUGENE, OREGON 97403
telephone (code 503) 342-1411

October 31, 1966

Mr. W. L. Griffith
Union Carbide Corp.
Building No. 9704-2
P.O. Box Y
Oakridge, Tennessee

Dear Mr. Griffith:

In response to your telephone inquiry of October 28th regarding the utility tunnel on the University of Oregon campus, please be advised that the following utility services are carried in our tunnels:

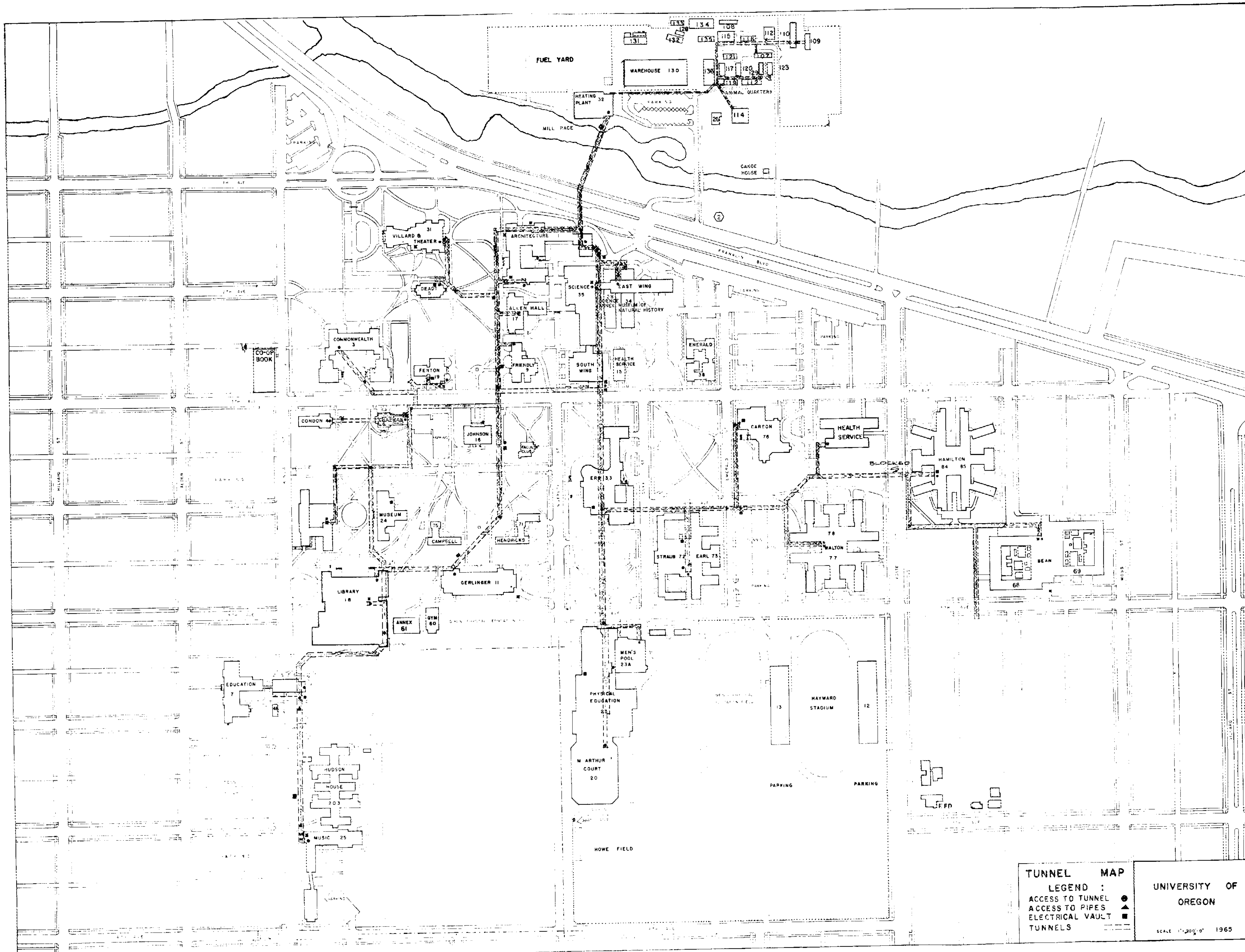
Irrigation Water
Telephone
Compressed Air, 20 psi
Cable Television
Steam (60 psi HP; 20 psi LP)
Condensate return
Chilled Water Supply and Return
Pump Circuits
Tunnel Lights
Clock Circuits
Primary Electrical Service, 4160 volts

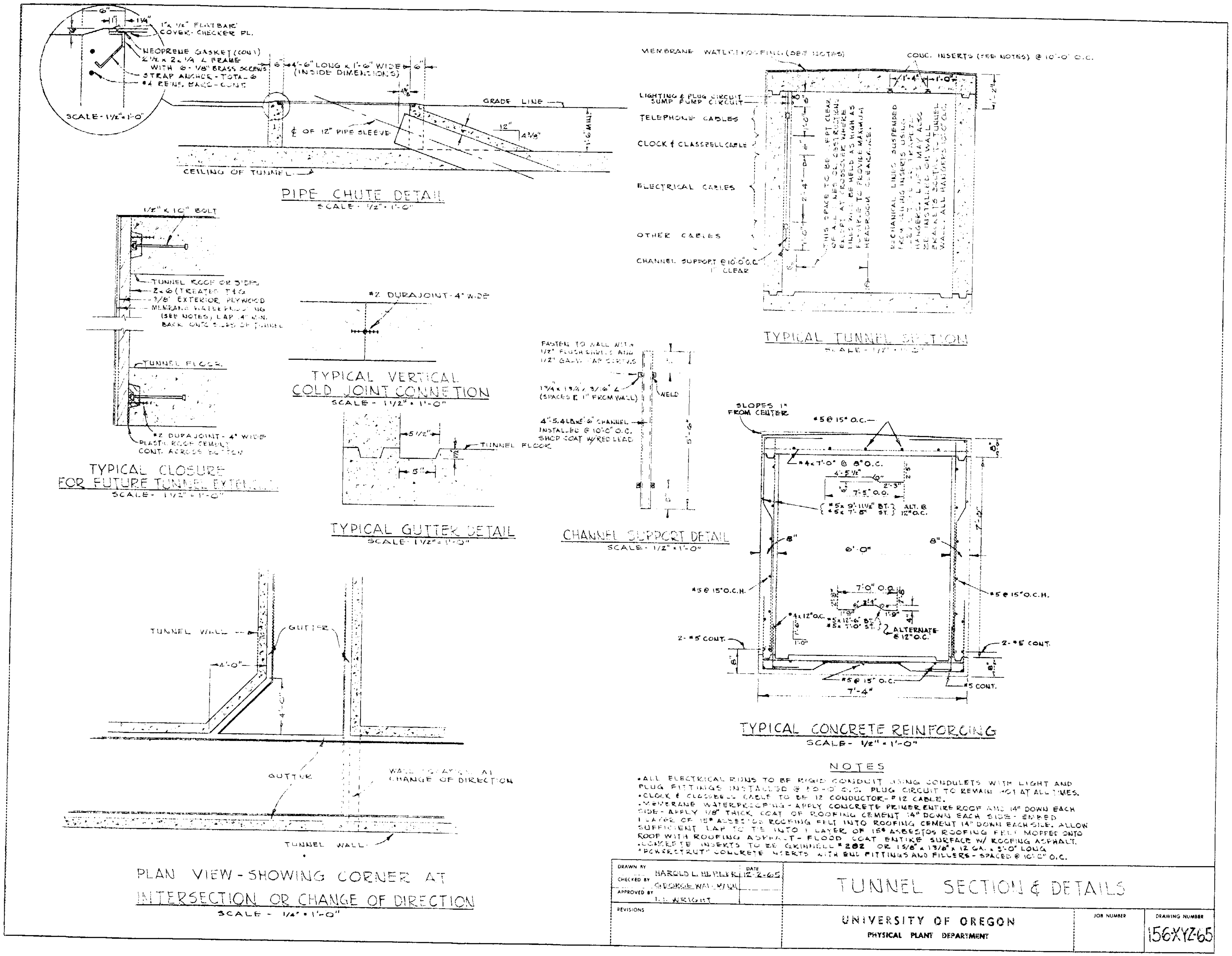
I am enclosing a tunnel map, and a drawing showing typical tunnel section details. I trust that this information will be of benefit to you in your Urban Renewal planning operations.

Sincerely,

James L. Henshaw, Superintendent
Department of Physical Plant

encl.


FUEL YARD
WAREHOUSE 130
HEATING PLANT 32
ANIMAL QUARTERS
MILL RACE
CANOE HOUSE
FRANKLIN BLVD
VILLARD & THEATER
ARCHITECTURE
SCIENCE 35
EAST WING
MUSEUM OF NATURAL HISTORY
ALLEN HALL
COMMONWEALTH 3
CO-OP BOOK
FENTON 19
FRIENDLY
SOUTH WING
HEALTH SERVICE
EMERALD
CONDON
JOHNSON 16
FACULTY CLUB
CARSON 76
HEALTH SERVICE
BLOCKED
HAMILTON
ERB 33
MUSEUM 24
CAMPBELL
HENDRICKS
STRAUB 72
EARL 73
WALTON 77
BEAN
LIBRARY 18
GERLINGER 11
ANNEX 61
GYM 60
MEN'S POOL 23A
EDUCATION 7
PHYSICAL EDUCATION
HAYWARD STADIUM
MARTHUR COURT 20
PARKING
HUDSON HOUSE 203
MUSIC 25
HOWE FIELD
TUNNEL MAP
LEGEND :
ACCESS TO TUNNEL
ACCESS TO PIPES
ELECTRICAL VAULT
TUNNELS
UNIVERSITY OF OREGON
1965


PIPE CHUTE DETAIL
SCALE - 1/2" = 1'-0"
GRADE LINE
CEILING OF TUNNEL
℄ OF 12" PIPE SLEEVE
4'-6" LONG x 1'-6" WIDE (INSIDE DIMENSIONS)
SCALE - 1 1/2" = 1'-0"
TYPICAL TUNNEL SECTION
TELEPHONE CABLES
CLOCK & CLASSBELL CABLE
ELECTRICAL CABLES
OTHER CABLES
TYPICAL CLOSURE FOR FUTURE TUNNEL EXTENSION
SCALE - 1 1/2" = 1'-0"
TYPICAL VERTICAL COLD JOINT CONNECTION
SCALE - 1 1/2" = 1'-0"
TYPICAL GUTTER DETAIL
CHANNEL SUPPORT DETAIL
SCALE - 1/2" = 1'-0"
TYPICAL CONCRETE REINFORCING
SCALE - 1/2" = 1'-0"
PLAN VIEW - SHOWING CORNER AT INTERSECTION OR CHANGE OF DIRECTION
SCALE - 1/4" = 1'-0"
TUNNEL WALL
GUTTER
NOTES
•ALL ELECTRICAL RUNS TO BE RIGID CONDUIT USING CONDULETS WITH LIGHT AND PLUG FITTINGS INSTALLED @ 50'-0" O.C. PLUG CIRCUIT TO REMAIN HOT AT ALL TIMES.
•CLOCK & CLASSBELL CABLE TO BE 12 CONDUCTOR - #12 CABLE.
•MEMBRANE WATERPROOFING - APPLY CONCRETE PRIMER ENTIRE ROOF AND 14" DOWN EACH SIDE - APPLY 1/8" THICK COAT OF ROOFING CEMENT 14" DOWN EACH SIDE - EMBED 1 LAYER OF 15# ASBESTOS ROOFING FELT INTO ROOFING CEMENT 14" DOWN EACH SIDE. ALLOW SUFFICIENT LAP TO TIE INTO 1 LAYER OF 15# ASBESTOS ROOFING FELT MOPPED ONTO ROOF WITH ROOFING ASPHALT - FLOOD COAT ENTIRE SURFACE W/ ROOFING ASPHALT.
•CONCRETE INSERTS TO BE GRINNELL #282 OR 15/8" x 13/8" x 12 GA. x 5'-0" LONG "POWERSTRUT" CONCRETE INSERTS WITH ALL FITTINGS AND FILLERS - SPACED @ 10'-0" O.C.
DRAWN BY HAROLD L. BERLER DATE 12-2-65
CHECKED BY GEORGE WALDMAN
APPROVED BY I. I. WRIGHT
REVISIONS
TUNNEL SECTION & DETAILS
UNIVERSITY OF OREGON
PHYSICAL PLANT DEPARTMENT
JOB NUMBER
DRAWING NUMBER
156XYZ-65

THE UNIVERSITY OF TEXAS
AUSTIN 78712

DIRECTOR OF PHYSICAL PLANT

August 29, 1966

Oak Ridge National Laboratory
Post Office Box X
Oak Ridge, Tennessee 37831

Attention: Mr. W. J. Boegly, Jr.
Health Physics Division

Gentlemen:

Your letter dated August 24, and written with regard to underground tunnels has been received. The University of Texas does make use of an extensive underground tunnel system on its Main Campus.

The dimensions of such tunnels vary. In the greatest number of cases structures of this character have internal dimensions of the following order: height 6'6"; width 6'0". The use of smaller structures has proven to be unwise here and we do have some members as large as 7'6" high and 10'0" wide. All of our structures involve a reinforced concrete construction.

Such tunnels are used for the distribution of steam, condensate, chilled water supply, chilled water return and compressed air. We have no gas lines in such structures.

Electrical and communications distribution systems are completely separated from the tunnel systems. They are cared for separately by fiber duct banks encased in concrete with divided manholes so that power is isolated from communications.

In the early stages expansion and contraction of lines in tunnels were cared for with devices which required periodic maintenance such as expansion joints. These have now all been removed and expansion chambers have been constructed to enclose convolutions or bends in the piping system. In this manner a continuous service is possible.

The information which I am providing is meager. If your interest warrants such an action, we will be glad to conduct a tour of inspection for you in the event that a visit to Austin is possible.

Sincerely yours,

Carl J. Eckhardt
Carl J. Eckhardt
Director of Physical Plant

bm

cc: Mr. C. R. von Bieberstein

UNIVERSITY *of* WASHINGTON
PHYSICAL PLANT DEPARTMENT
SEATTLE 5, WASHINGTON

August 30, 1966

Mr. W. J. Boegly, Jr.
Health Physics Division
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37831

Dear Mr. Boegly:

The University of Washington has an extensive underground utility tunnel system which was constructed and is being expanded to satisfy several criteria:

1. Security and control of service to ensure reliability,

2. Achieve maximum flexibility in siting new buildings, (tunnels are thirty to seventy feet below earth surface, substantially below building foundations and basements),

3. Reduce maintenance and operating costs,

4. Flexibility for the installation of new utilities or the expansion of existing services,

5. Aesthetics.

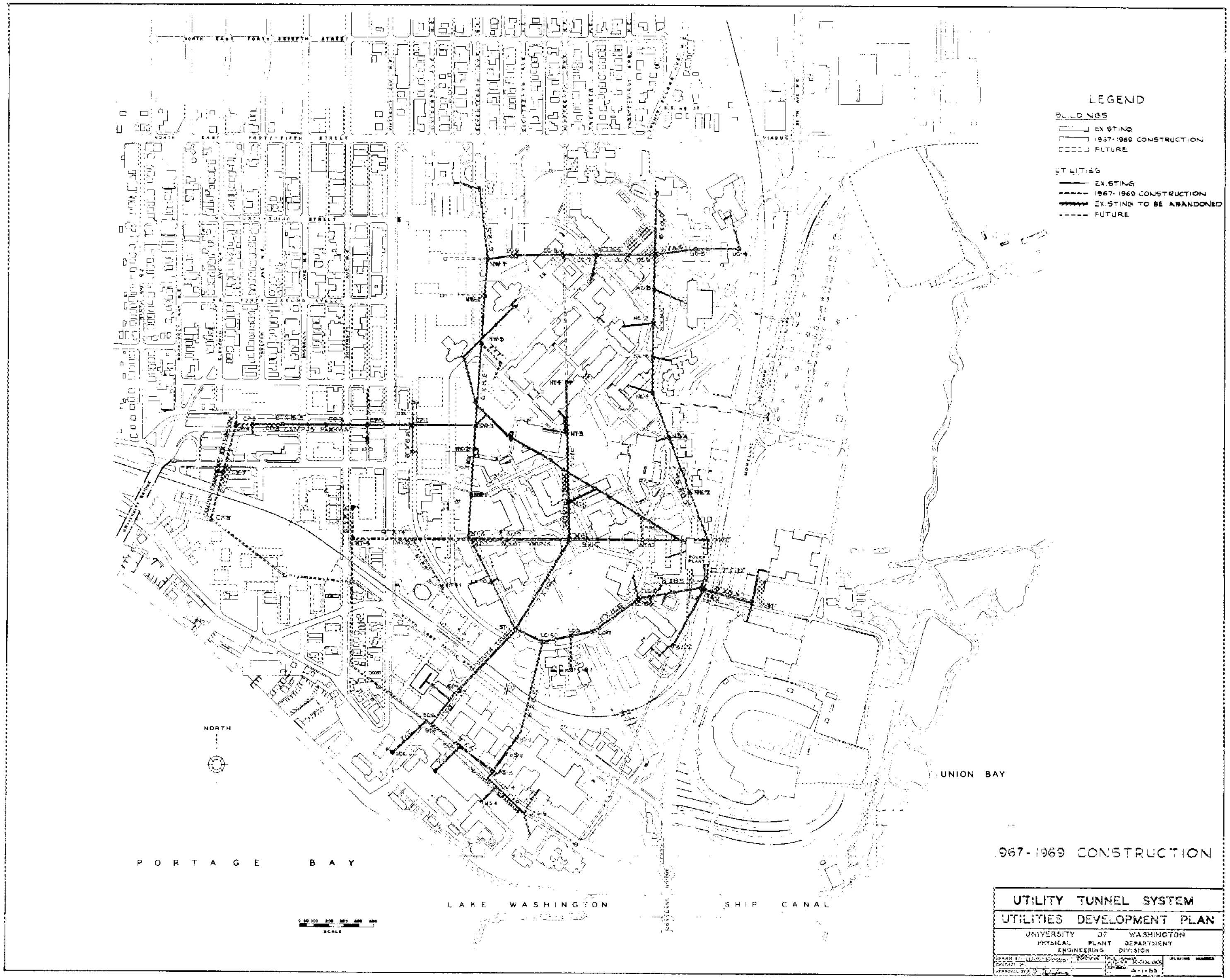
Attached is a copy of a drawing entitled "Utility Tunnel System" which shows existing tunnels as well as those contemplated for future construction. Also attached are copies of drawings Nos. A3-1391 and A3-1392 which illustrate University of Washington standards for both open cut and tunnelled utility tunnels. The standard services provided in the tunnels are indicated on these latter two drawings.

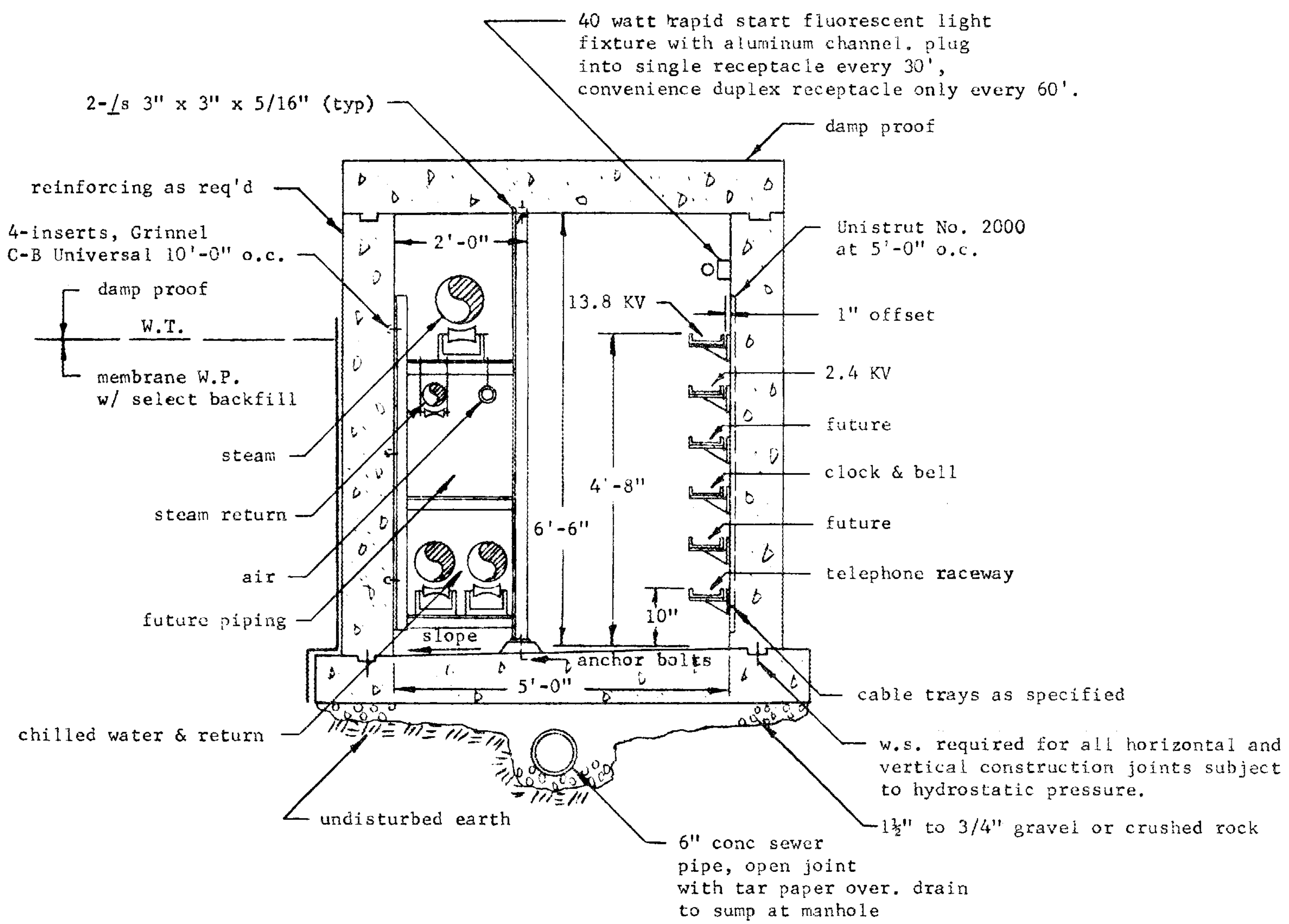
Yours very truly,

J. W. Harding

J. W. Harding, Director

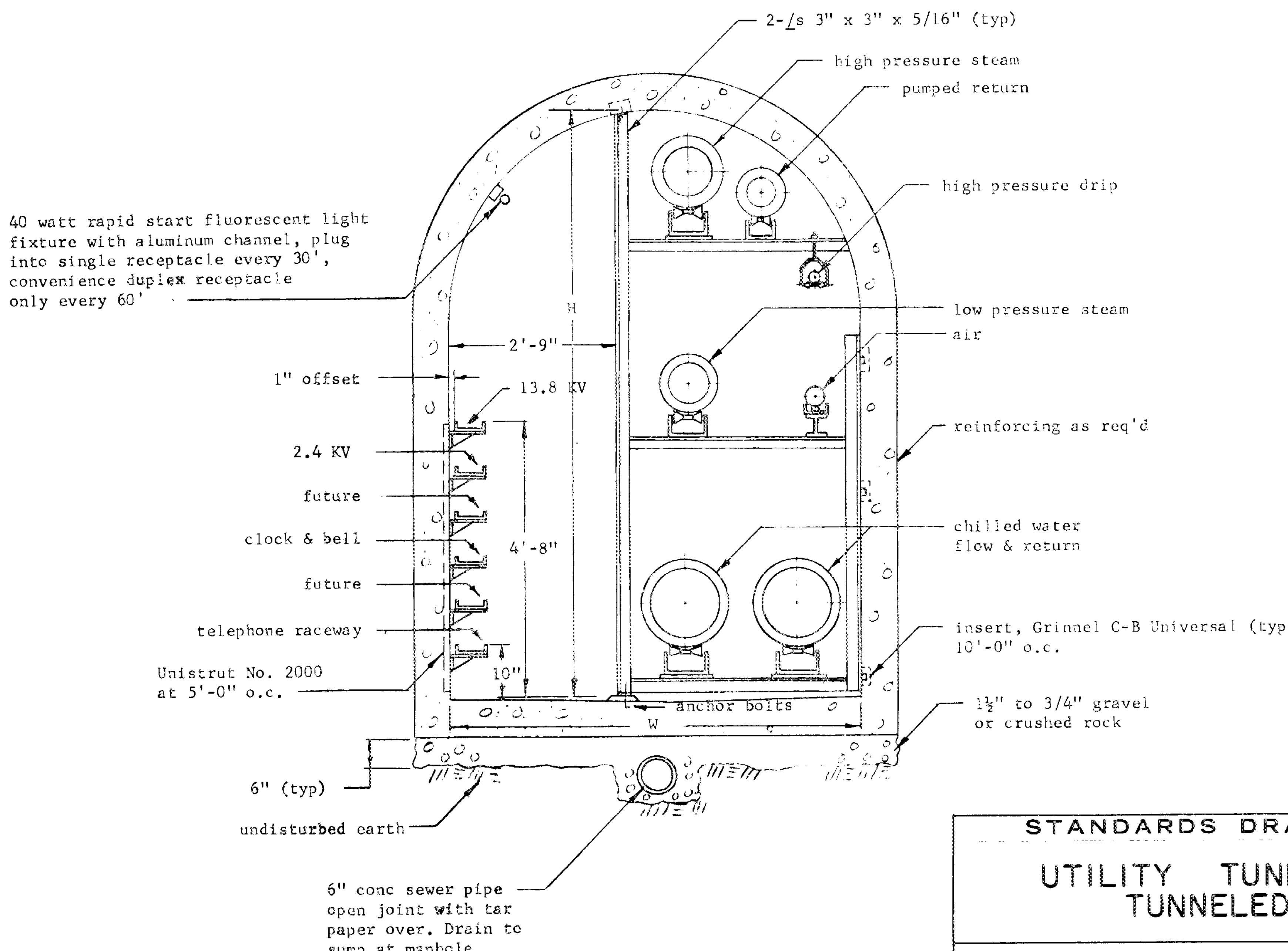
JWH:vk
encl.


LEGEND
BUILDINGS
EXISTING
1967-1969 CONSTRUCTION
FUTURE
UTILITIES
EXISTING
1967-1969 CONSTRUCTION
EXISTING TO BE ABANDONED
FUTURE
NORTH
PORTAGE BAY
LAKE WASHINGTON SHIP CANAL
UNION BAY
SCALE
1967-1969 CONSTRUCTION
UTILITY TUNNEL SYSTEM
UTILITIES DEVELOPMENT PLAN
UNIVERSITY OF WASHINGTON
PHYSICAL PLANT DEPARTMENT
ENGINEERING DIVISION



Mechanical piping shall be located to the inside at all tunnel changes of direction. Axis of rotation shall be centered about the inside tunnel wall.

STANDARDS DRAWING	Drawn	L E	3/17/66
UTILITY TUNNEL - OPEN CUT	Checked		
	Approved		
	REVISION	▷	Date
UNIVERSITY OF WASHINGTON PHYSICAL PLANT DEPARTMENT ENGINEERING DIVISION	Drawing No. A3-1391		Standards No. SD-71.01



STANDARD SIZES

H	W
10'-0"	7'-0"
14'-0"	9'-0"

Mechanical piping shall be located to the inside at all tunnel changes of direction. Axis of rotation shall be centered about the inside tunnel wall.

STANDARDS DRAWING	Drawn	L.E.	3/18/66
UTILITY TUNNEL - TUNNELED	Checked		
	Approved		
	REVISION	▷	Date
UNIVERSITY OF WASHINGTON PHYSICAL PLANT DEPARTMENT ENGINEERING DIVISION	Drawing No. A3-1392	Standards No. SD-71.02	

DEPARTMENT OF THE ARMY
USARAL YUKON COMMAND AND FORT WAINWRIGHT
APO SEATTLE 98731
Office of the Post Engineer

ARYEN-U

23 September 1966

Union Carbide Corporation
Nuclear Division
ATTN: W.L. Griffith
Oakridge, Tennessee

Dear Mr. Griffith;

In reply to your message of 20 September 1966 requesting data on the use of underground tunnels for utilities distribution, the following information is offered:

Underground tunnels or utilidors are used for utilities services to almost all buildings on this post. Heating steam, condensate return, water and sewage piping systems are included. In addition the post telephone cables and circuits are frequently run in the same utilidor as other services. Electrical power is not included.

The utilidors are generally of reinforced concrete with removable top lids. Sizes vary from 2' x 2' inside for smaller building branches to 5' x 5' and larger for main runs. Access manholes are spaced 200 to 400 feet apart and at major branches or changes in direction. Piping is frequently supported on "unistrut" framing members using pipe support rolls, alignment guides, and expansion joints. Utilidors generally are graded so that any ground water that should enter will flow to a sump located in a manhole.

Water piping is galvanized steel with Dresser couplings except that flanged joints are used at fittings for branches and intersections. The water mains are anchored to the concrete utilidor walls at all branches and at approximately 100 foot intervals on straight runs to prevent excessive accumulation of movement.

Steam and condensate return piping is schedule 40 black steel with butt weld fittings. Slip type expansion joints of the "gun packed" type are generally used. Steam, return and water pipes are insulated.

ARYEN-U
Mr. W.L. Griffith

23 September 1966

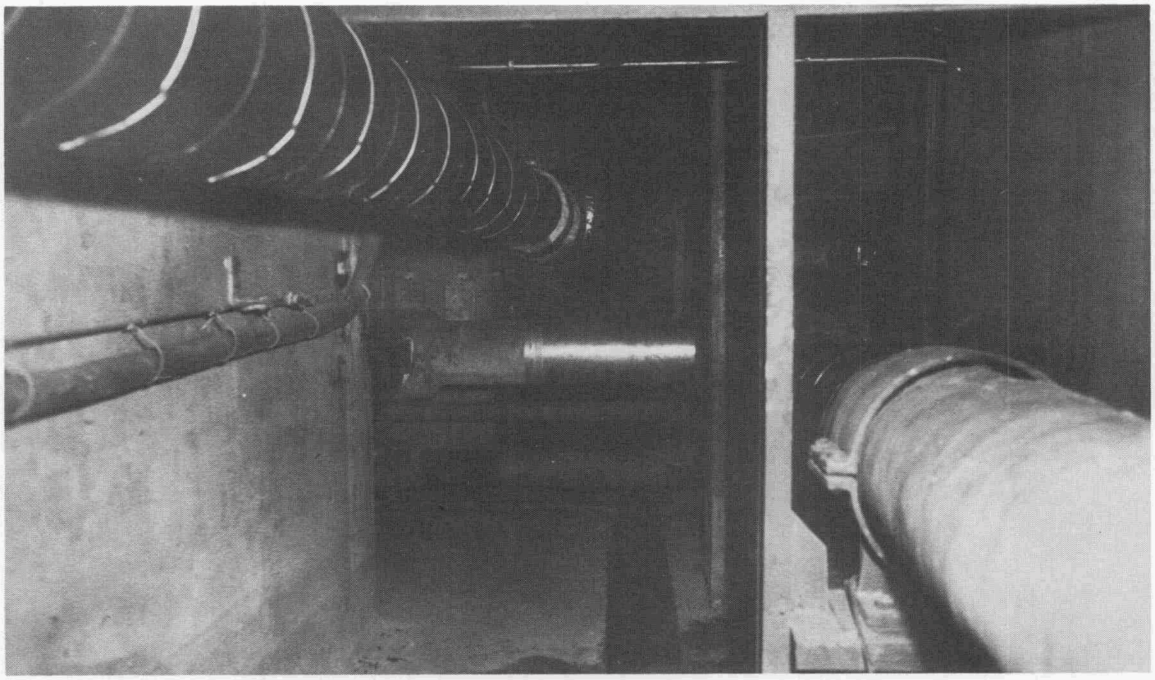
Sewers are usually of pressure type cement asbestos supported on and strapped to concrete blocks on the bottom of the utilidor. Sewage pumping stations are used where required to eliminate excessive depth of utilidors.

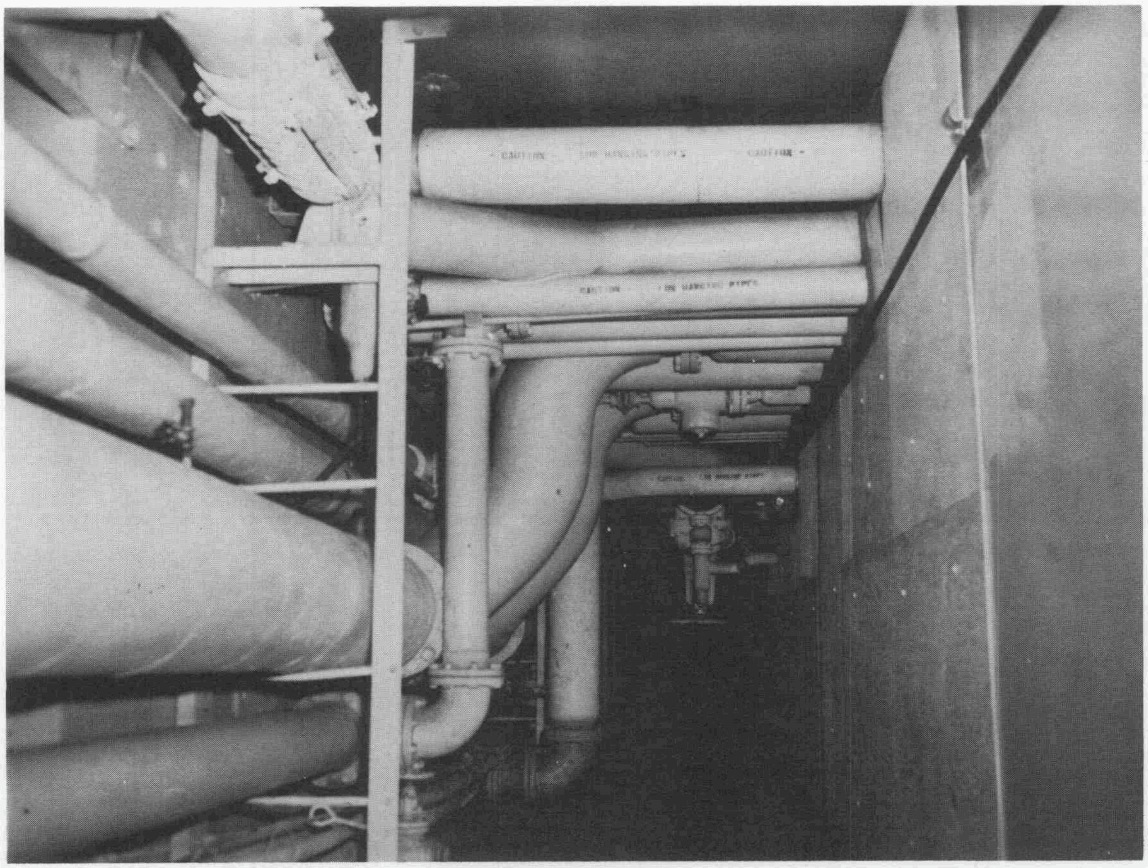
Use of these underground utilidors has been very satisfactory at this post where extremely cold winter temperatures prevail.

Sincerely yours

DONALD J. BLICHMANN
Major, CE
Engineer

2 Incl
2 photos of
utilidors





Interior of Fort Wainwright Utilidors

XUA005

RR RUKXJW

DE RUEPXU 076 2631812

ZNR UUUUU

R 201732Z SEP 66

W. L. Griffith
File

FM UNION CARBIDE CORP NUCLEAR DIV W L GRIFFITH OAKRIDGE TENN

TO POST ENGINEER EILSON AIR FORCE BASE ALASKA

AEC

BT

UNCLAS WE ARE CURRENTLY MAKING A STUDY ON THE USE OF UNDERGROUND TUNNELS FOR UTILITIES. WE WOULD LIKE TO KNOW IF YOUR BASE USES A SYSTEM OF THIS TYPE. IF SO, WHAT UTILITIES, SUCH AS WATER, GAS, POWER ETC., DO YOU INCLUDE.

ANY INFORMATION YOU CAN PROVIDE ON THIS SUBJECT WILL BE APPRECIATED

BT

NNNN

Reply from Eielson Air Force Base, Alaska

```
            R 010145Z OCT 66
FM 5010CMBTSPTGP EIELSON AFB ALASKA
TO RUCIPRA/UNION CARBIDE CORP NUCLEAR DIV W L GRIFFITH OAKRIDGE TENN
            INFO RUKDAG/AAC
            BT
ILCE 05861 SEPTEMBER 66.
            REFERENCE YOUR UNCLASSIFIED MESSAGE R2017322 SEP 66. THIS BASE
UTILIZES A CONCRETE UTILIDOR UNDERGROUND SYSTEM FOR STEAM LINE
DISTRIBUTION SYSTEM FROM CENTRAL HEAT PLANT, WATER ANS SEWAGE
DISTRIBUTION SYSTEMS AND SOME COMMUNICATIONS LINES. WE HAVE SOME
UTILIDORS DESIGNED TO CRAWL THROUGH AND SOME TO WALK THROUGH.
NEARBY FORT WAINWRIGHT, FORMERLY LADD AIR FORCE BASE, HAS WALK
THROUGH TUNNEL SYSTEM. SUGGEST VISIT TO BOTH INSTALLATIONS AS BEST
MEANS TO GET FULL INFORMATION DESIRED. YOUR MESSAGE NOT CLEAR
CONCERNING WHETHER YOU REQUEST INFORMATION CONCERNIG SIZE, DESIGN,
            FUNCTION, COST, CONSTRUCTION, OR MAINTENANCE PROB
EMS, AND COSTS,
            PRACTICALLY ETC. WE WILL TRY TO ANSWER SPECIFIC QUESTIONS IF YOU
WRITE BUT BELIEVE VISIT PREFERABLE.
            BILLY BURKE, LT COLONEL, USAF
BASE CIVIL ENGINEER  EIELSON AFB ALASKA
            BT




NNNN*
```

MEMORANDUM OF CONFERENCE OR CONVERSATION

DATE | TIME | [X] TELEPHONE [ ] PERSONAL

ORIGINATING PARTY	OTHER PARTIES
W. J. Boegly	Mr. Lamutt
W.L. Griffith	Eielson Air Force Base, Alaska

SUBJECT:

Phone Call for Additional Information on Eielson Air Force Base, Alaska

DISCUSSION:

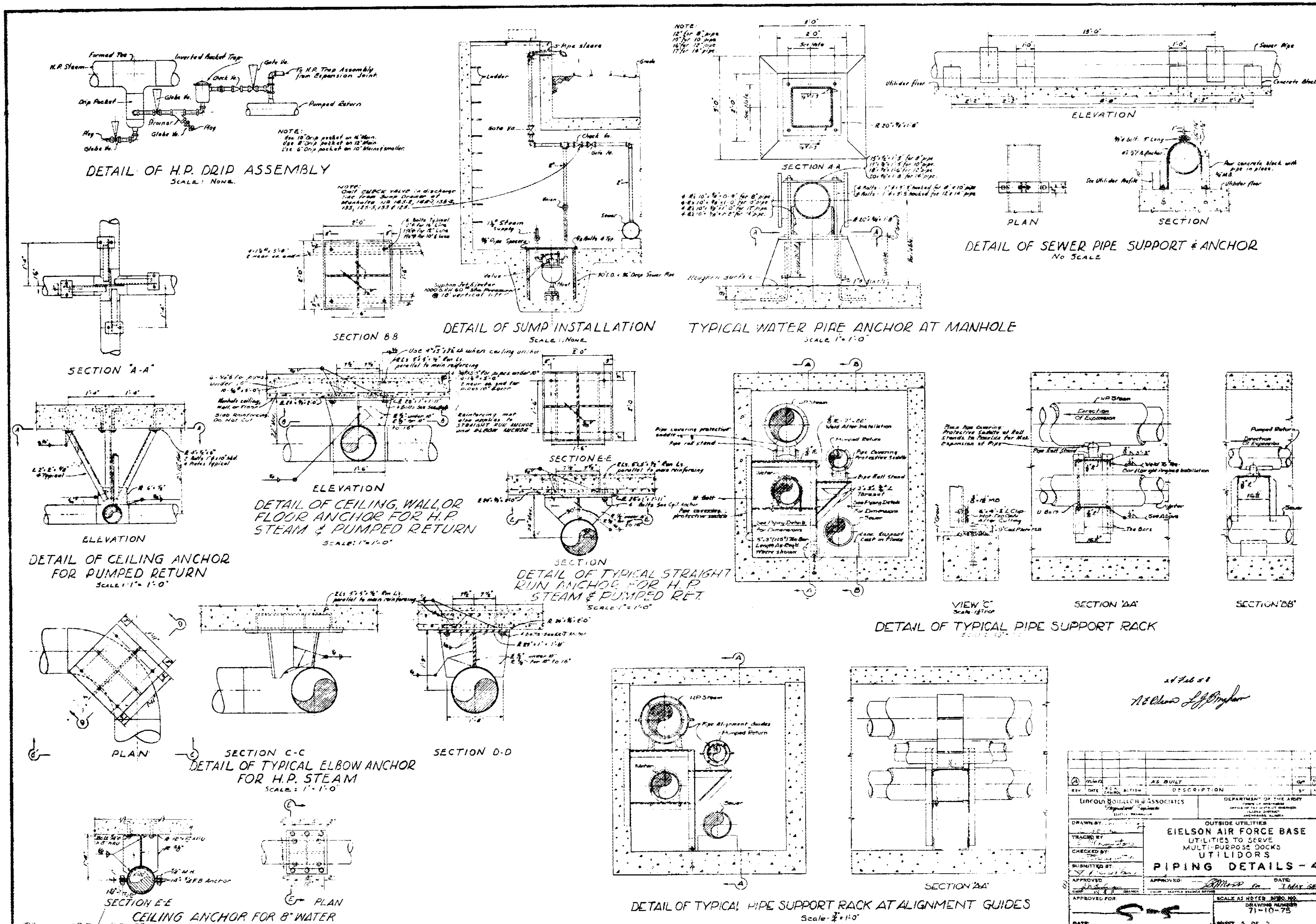
Call was made to Lt. Colonel Billy Burke to obtain additional data on utility tunnels at Eielson Air Force Base. Lt. Colonel Burke was not in and we talked to Mr. Lamutt. Mr. Lamutt said their tunnels were similar to Fort Wainwright and contained water, sewerage, communications, steam, returns, some electrical, and the grounding system. He reported that the average cost of a 4' x 5' tunnel was about $125 - $250/ft., including piping. Mr. Lamutt also said he would send typical cross-section drawings.

Mr. Lamutt suggested that we contact the Alaska District Corps of Engineers at Anchorage.

CONCLUSION OR AGREEMENTS

DISTRIBUTION: | SIGNED

UCN-693
(123 7-59)


DETAIL OF H.P. DRIP ASSEMBLY
SCALE: NONE
SECTION "A-A"
SECTION B-B
DETAIL OF SUMP INSTALLATION
SCALE: NONE
TYPICAL WATER PIPE ANCHOR AT MANHOLE
SCALE 1" = 1'-0"
ELEVATION
PLAN
SECTION
DETAIL OF SEWER PIPE SUPPORT & ANCHOR
NO SCALE
ELEVATION
DETAIL OF CEILING ANCHOR FOR PUMPED RETURN
SCALE: 1" = 1'-0"
DETAIL OF CEILING, WALL, OR FLOOR ANCHOR FOR H.P. STEAM & PUMPED RETURN
SCALE: 1" = 1'-0"
SECTION E-E
SECTION
DETAIL OF TYPICAL STRAIGHT RUN ANCHOR FOR H.P. STEAM & PUMPED RET.
SCALE: 1" = 1'-0"
VIEW "C"
SECTION "AA"
SECTION "BB"
DETAIL OF TYPICAL PIPE SUPPORT RACK
PLAN
SECTION C-C
SECTION D-D
DETAIL OF TYPICAL ELBOW ANCHOR FOR H.P. STEAM
SCALE: 1" = 1'-0"
SECTION E-E
PLAN
CEILING ANCHOR FOR 8" WATER
SCALE: 1" = 1'-0"
SECTION "AA"
DETAIL OF TYPICAL PIPE SUPPORT RACK AT ALIGNMENT GUIDES
AS BUILT
DESCRIPTION
LINCOLN BOUILLON & ASSOCIATES
DEPARTMENT OF THE ARMY
OUTSIDE UTILITIES
EIELSON AIR FORCE BASE
UTILITIES TO SERVE
MULTI-PURPOSE DOCKS
UTILIDORS
PIPING DETAILS - 4
71-10-75

R 072020Z OCT 66

FM UNION CARBIDE CORP W L GRIFFITH OAKRIDGE TENN

TO ALASKA DISTRICT ENGINEERS TO DISTRICT ENGINEER ELMENDORF AFB

ANCHORAGE ALASKA

AEC

BT

UNCLAS A STUDY IS IN PROGRESS AT THE OAK RIDGE NATIONAL LABORATORY TO EVALUATE THE APPLICATION OF UNDERGROUND UTILITY TUNNELS IN URBAN RENEWAL AREAS. A SURVEY IS BEING MADE TO OBTAIN AVAILABLE INFORMATION ON THIS CONCEPT. WE UNDERSTAND THAT YOUR OFFICE IS RESPONSIBLE FOR DESIGN AND CONSTRUCTION OF UTILITY SYSTEMS FOR BASES IN ALASKA.

ALTHOUGH WE REALIZE THAT SEVERE COLD WEATHER CONDITIONS ARE AN IMPORTANT FACTOR IN THE DECISION TO INSTALL TUNNELS IN ALASKA, ARE THERE OTHER FACTORS SUCH AS MAINTENANCE COSTS THAT ENTER INTO THIS DECISION IF THERE ARE DESIGN CRITERIA, SPECIFICATIONS, DRAWINGS, PHOTOGRAPHS, AND COSTS THAT WOULD BE TYPICAL FOR THE SYSTEMS USED IN ALASKA, WE WOULD APPRECIATE IT IF YOU COULD MAKE THEM AVAILABLE TO US. WE WOULD ALSO APPRECIATE HEARING ANY GENERAL COMMENTS YOU WOULD CARE TO MAKE ON EXPERIENCE WITH THESE SYSTEMS IN ALASKA.

PLEASE SEND YOUR REPLY TO W L GRIFFITH BUILDING 9704-2 UNION CARBIDE CORPORATION NUCLEAR DIVISION P O BOX Y OAK RIDGE TENNESSEE 37830

DEPARTMENT OF THE ARMY
ALASKA DISTRICT, CORPS OF ENGINEERS
P.O. BOX 7002
ANCHORAGE, ALASKA 99501

IN REPLY REFER TO
NPAEN-DB-B

25 October 1966

Mr. W. L. Griffith
Building 9704-2
Union Carbide Corporation
Nuclear Division, P. O. Box Y
Oak Ridge, Tennessee 37830

Dear Mr. Griffith:

This letter is in reference to your telegram dated 8 October 1966.

Utilities in Alaska are normally buried in the conventional manner. When permafrost and frost penetration become a problem, utilities are protected by placing them in steam heated utilidors.

Utilidors usually carry water, sewer, steam mains, and condensate return lines. The utilidors have a rectangular cross section, and are constructed of reinforced concrete. Water and steam piping are supported by unistrut-type, prefabricated racks. Sewer piping is supported on cast in place concrete pedistals.

Originally, utilidors were designed to allow walk through maintenance but were extremely expensive to build. To reduce cost, a low wide "Pancake" type utilidor has been adopted. The utility piping is placed in a single horizontal layer with the lid designed to be removable.

Some wooden and earth utilidors have been built in an attempt to reduce cost. Rot and maintenance problems have proved that this type utilidor is impractical. Metal utilidors have also been used. They consist of two corrugated metal semicircles. The sections are seated on a specially formed rubber gasket for water tightness. ARMCO metal products can give you detailed information

NPAEN-DB-B
Mr. W. L. Griffith

24 October 1966

about this type utilidor. The primary objection to a round utilidor is the requirement of placing two levels of piping in the semicircle. Any maintenance in the lower level also requires removal of the upper level.

Costs here in Alaska are not representative for the "Lower 48", but our estimate of cost is approximately $75.00 per running foot. This cost is for material, framing and placing concrete for the utilidor. It does not reflect the cost of excavation or piping.

The utilidor lids are sometimes designed to be sidewalks, but usually the grade is determined by the sewer line.

In Alaskan permafrost areas, utilidors can cause a serious problem by thawing the ground around the building foundations. Thus normal practice requires a 50 foot space between utilidors and buildings.

If our office can be of any further assistance, please let us know.

Sincerely yours,

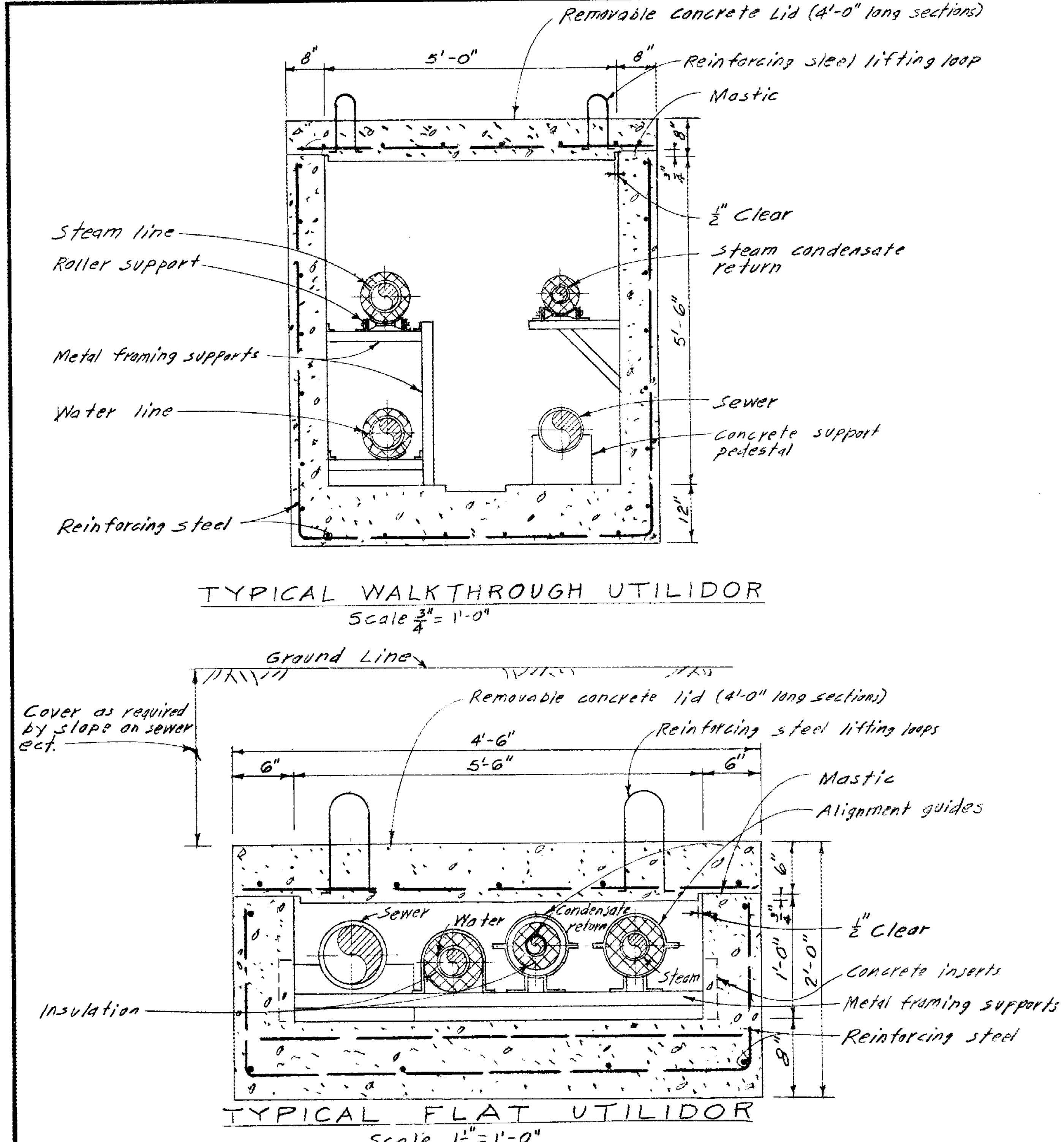
W. A. Wells

W. A. WELLS
Acting Chief, Engineering Division

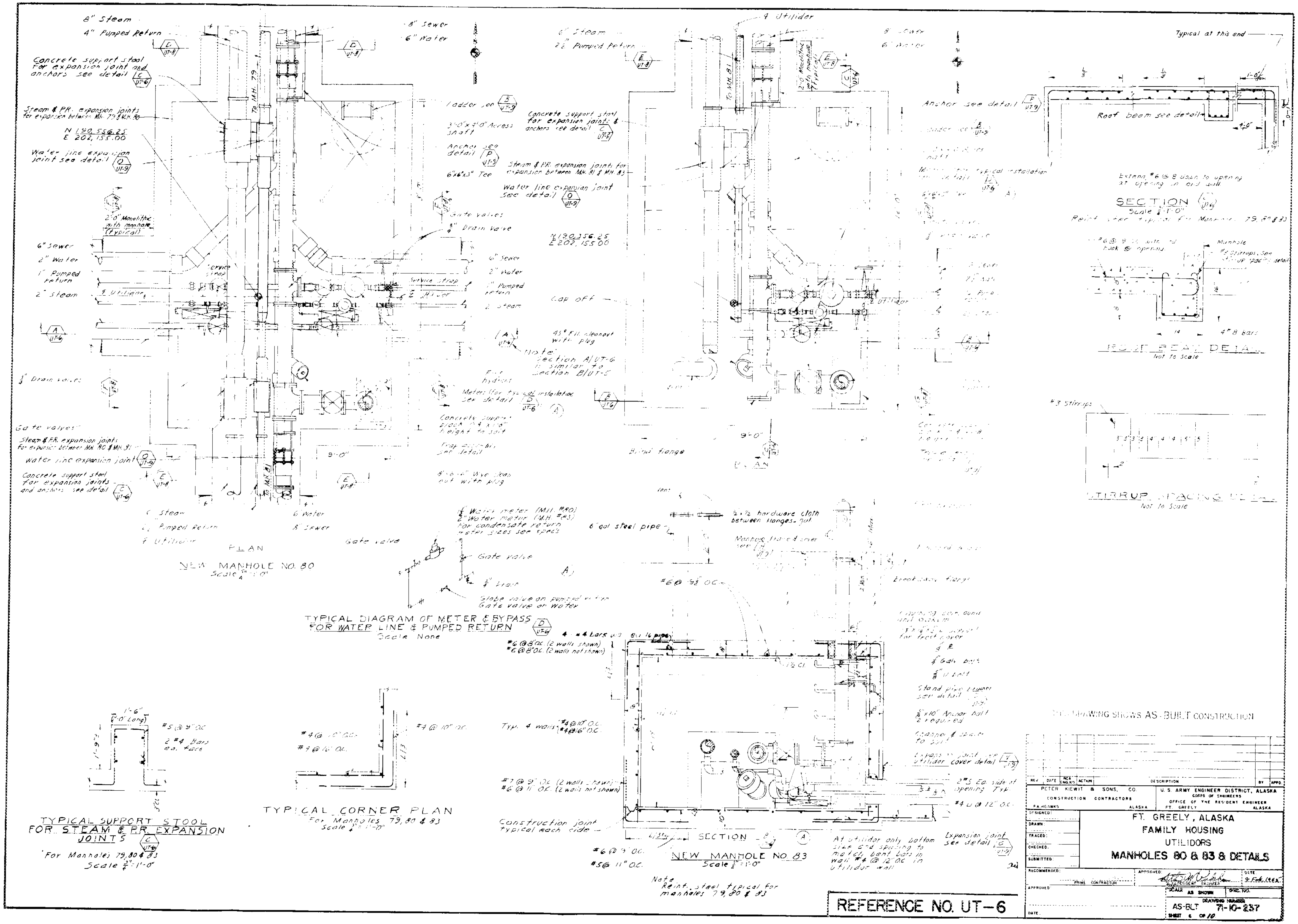
2 Incl
1. Guide Specs
2. Details

CORPS OF ENGINEERS

U.S. ARMY



U. S. ARMY ENGINEER DISTRICT, ALASKA CORPS OF ENGINEERS ANCHORAGE, ALASKA	
DESIGNED: DRAWN: TRACED: CHECKED: SUBMITTED: CHIEF SECTION	UTILIDOR DETAILS
RECOMMENDED:	APPROVED: DATE
	SCALE SPEC. NO. DRAWING NUMBER SHEET OF



8" Steam
4" Pumped Return
Concrete support stool for expansion joint and anchors see detail
Water line expansion joint see detail
6" Sewer
2" Water
1" Pumped return
2" Steam
Gate valves
PLAN
NEW MANHOLE NO. 80
TYPICAL DIAGRAM OF METER & BYPASS FOR WATER LINE & PUMPED RETURN
Scale None
Cap off
6" gal steel pipe
SECTION
Scale 1" = 1'-0"
Roof beam see detail
ROOF BEAM DETAIL
Not to Scale
STIRRUP SPACING DETAIL
Not to Scale
TYPICAL SUPPORT STOOL FOR STEAM & P.R. EXPANSION JOINTS
For Manholes 79, 80 & 83
TYPICAL CORNER PLAN
For Manholes 79, 80 & 83
SECTION
NEW MANHOLE NO. 83
Note: Reinf. steel typical for manholes 79, 80 & 83
THIS DRAWING SHOWS AS-BUILT CONSTRUCTION
PETER KIEWIT & SONS, CO.
CONSTRUCTION CONTRACTORS
U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
OFFICE OF THE RESIDENT ENGINEER
FT. GREELY, ALASKA
FAMILY HOUSING
UTILIDORS
MANHOLES 80 & 83 & DETAILS
AS-BLT
71-10-237
REFERENCE NO. UT-6

INTERNAL CORRESPONDENCE

NUCLEAR DIVISION

POST OFFICE BOX Y, OAK RIDGE, TENNESSEE 37831

To (Name) J. C. Bresee
Company Building 4500 N
Location ORNL

Date September 26, 1966

Originating Dept. Process Analysis

Answering letter date

Copy to W. J. Boegly, Jr.
A. M. Christman
R. F. Hibbs
G. R. Jasny
F. S. Patton
File

Subject Visit to NASA-Houston
September 13, 1966

Y-KA-22

The Manned Spacecraft Center was visited September 13, 1966, to discuss their use of underground utility tunnels. Messrs. J. Welch, E. Erickson, and G. E. Sommers participated in the discussions. The information obtained is summarized below:

1. General - An important design consideration for land use at the NASA site was to provide a spread campus-like atmosphere; therefore, all of the utilities are underground. Underground utility tunnels were provided to accommodate heating and cooling piping, electric power, telephone and signal circuits. The sewers, potable water, and natural gas were laid underground by conventional direct-burial methods.

2. Preliminary Studies - Preliminary designs and cost estimates were made on three types of tunnels to determine the most economical type. These concepts were:

   a. All metal, multi-plate pipe-arch type with a concrete floor poured inside.

   b. A metal, multi-plate arch roof with concrete walls and floor slab.

   c. All reinforced concrete box-type.

   The reinforced concrete box-type tunnel was chosen as providing the largest amount of useful space with the least expense. Typical cross-sections are shown in Figure 1. A plan of a typical sump pump and ventilation station is also shown.

3. Layout - The general layout of the NASA Utility Tunnel complex is shown on the attached drawing.

The Utilities Tunnel was planned in accordance with the modular system (one module - 4'-8") of the building complex. All centerline dimensions were a multiple of one module, and all pipe supports and pipe anchors were spaced at three modules (14'-0") on centers.

Consideration was given to the needs of future buildings in the planning of the Utilities Tunnel. Stub-outs were provided and covered with removal concrete bulkheads for future use.

4. Design - Minimum expense was the prime consideration in the design of the tunnels. The following design criteria were used:

   a. The top of the tunnel was set at the highest safe elevation possible under road crossings so that excavation was held to a minimum.

   b. Inside vertical dimensions of the tunnel were set at the minimum to provide working head room.

   c. Inside horizontal dimensions were varied in accordance with the utility requirements. Seven different size tunnels are used with inside horizontal dimensions of 13'-0", 12'-0", 11'-0", 10'-0", 9'-0", 8'-0", and 6'-6".

   d. Although no longitudinal slope was used for drainage of water in the original tunnels in order to minimize excavation, recent additions are sloped about 1/16 inch per foot to provide better drainage. Drainage water empties into strategically located sump pits with permanent pumps which discharge all excess water into outside drains.

   e. Tunnels under roads are designed for H-20 type loading. Tunnels not under roads or buildings are designed to take the earth weight on them plus a 6,000-pound axle load. This permits the use of cars or small trucks on them and eliminates the double amount of reinforcing required for loads of the H-20 type. This was deemed necessary because of the exceptionally long length of the tunnel.

      Tunnels under buildings are designed to take the entire load imposed upon them.

   f. The walls and roof of the tunnels were designed as one unit, and together with the floor slab acted as a rigid box to minimize the thickness required and the quantity of reinforcing.

g. Access hatches for placing pipe in the tunnel were held to a minimum length and width. Threaded inserts were provided in the bottom of the roof slab for easy handling of the pipe after it is inside the tunnel.

h. Locations of sump pits were also utilized to accommodate the vent fans. An outside access was also provided at these locations. Access into the tunnel is available at these outside locations and in all mechanical rooms in the buildings. The outside openings require use of a key when operated from the outside.

i. Steel pipe supports inside the tunnel are the minimum size required to accommodate pipe guides required. Steel pipe anchors vary in size with the pipe and in accordance with the thrust imposed upon them. Pipes not requiring steel supports or anchors rest on concrete pads above the floor slab. These pads also serve as bases for the steel supports and anchors.

Insets were provided in the wall for installation of electrical conduit trays and in some instances for support of telephone conduit. Most telephone conduit utilizes the steel pipe supports for routing and support.

j. A waterproof membrane completely encases the tunnel. Water stops were used at all concrete joints. A curb around the tunnel opening into each building was provided to minimize the possibility of water entering the tunnel through the opening.

5. Costs - Typical costs in 1963 for tunnels excluding excavation and piping installation are shown below. It is believed that the costs for the 12- and 13-foot sizes are disproportionately high because only short sections in these sizes were constructed at this time. A sump and ventilation station costs about $2,000.

Width (ft)	Cost ($/ft)
6.5	100
8.0	136
9.0	140
10.0	150
11.0	165
12.0	230
13.0	240

6. Operation - Operation of the utility tunnels has been very satisfactory. Few problems have been encountered. Although the sensitive signal lines

have been shielded, no difficulties have been encountered by having the utilities grouped together in the tunnel. An occasional steam leak has occurred but without major mishap. Tunnel temperatures typically are 90° F to 100° F.

In summary, it appears that the NASA experience will be valuable in developing a municipal utility tunnel concept.

W L Griffith

W. L. Griffith

WLG:otb

Attachment

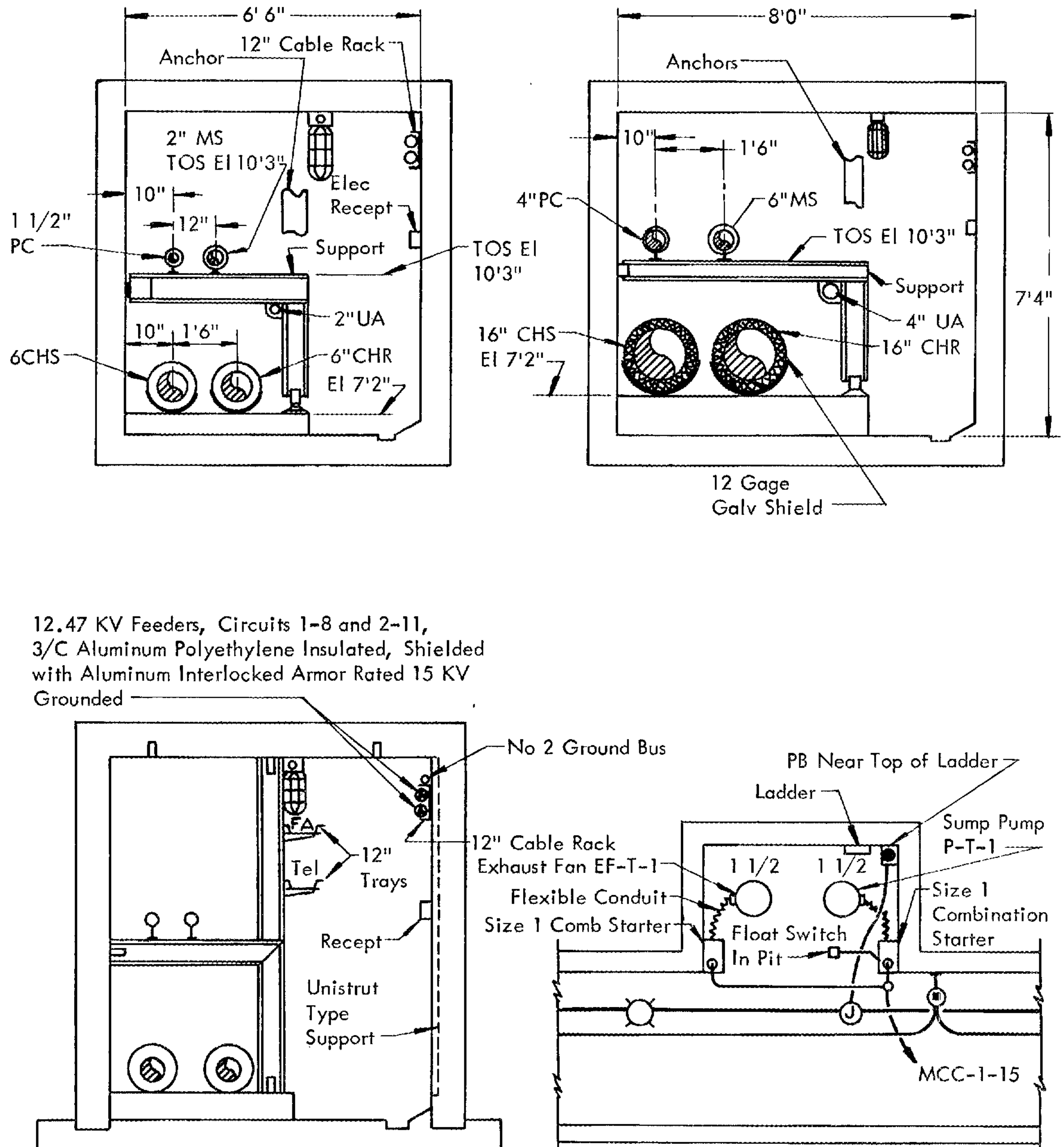
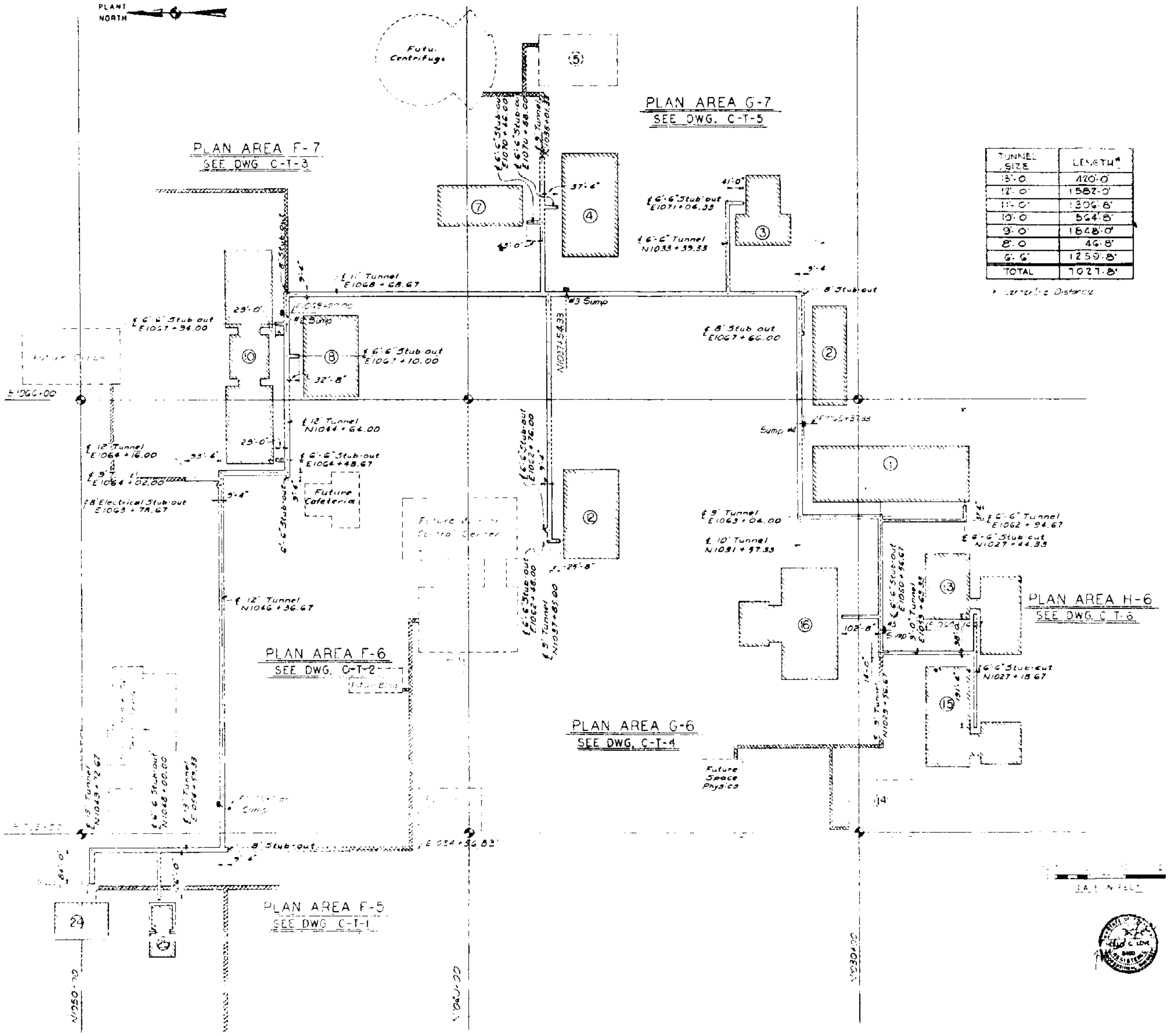
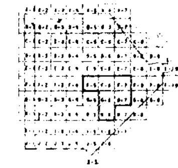


Figure 1. Upper Right, Upper Left, and Lower Left - Typical Cross Sections of NASA Utility Tunnels. Lower Right - Plan of Typical Sump and Ventilation Station.



TUNNEL SIZE	LENGTH*
13'-0	420'-0'
12'-0'	1582'-0'
11'-0'	1306'-8'
10'-0'	564'-8'
9'-0'	1648'-0'
8'-0	46'-8'
6'-6'	1259'-8'
TOTAL	7027'-8'

* Centerline Distance



REVISION	DATE	DESCRIPTION	BY
		This Drawing Added	

BROWN & ROOT INC
HOUSTON, TEXAS
ARCHITECT ENGINEER

ASSOCIATED ARCHITECTS
Brooks & Barr, Austin, Texas
Harvin C. Moore, Houston, Texas
Mackie & Kamrath, Houston, Texas
Wirtz Calhoun Tungate & Jackson

CONSULTANTS – PLANNING & DESIGN
Charles Luckman Associates, Los Angeles, New York

CONSULTING MECHANICAL ENGINEER
Bernard Johnson & Associates, Houston, Texas

U. S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

MANNED SPACECRAFT CENTER
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
CLEAR LAKE, HARRIS COUNTY, TEXAS

SITE DEVELOPMENT

UTILITIES TUNNEL LAYOUT
BUILDING COMPLEX

C-T-1B

HOLMES & NARVER, INC.
ENGINEERS · CONSTRUCTORS
828 SOUTH FIGUEROA STREET
LOS ANGELES, CALIF. 90017
TELEPHONE 627-4377

October 26, 1966

Mr. William Boegly
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee

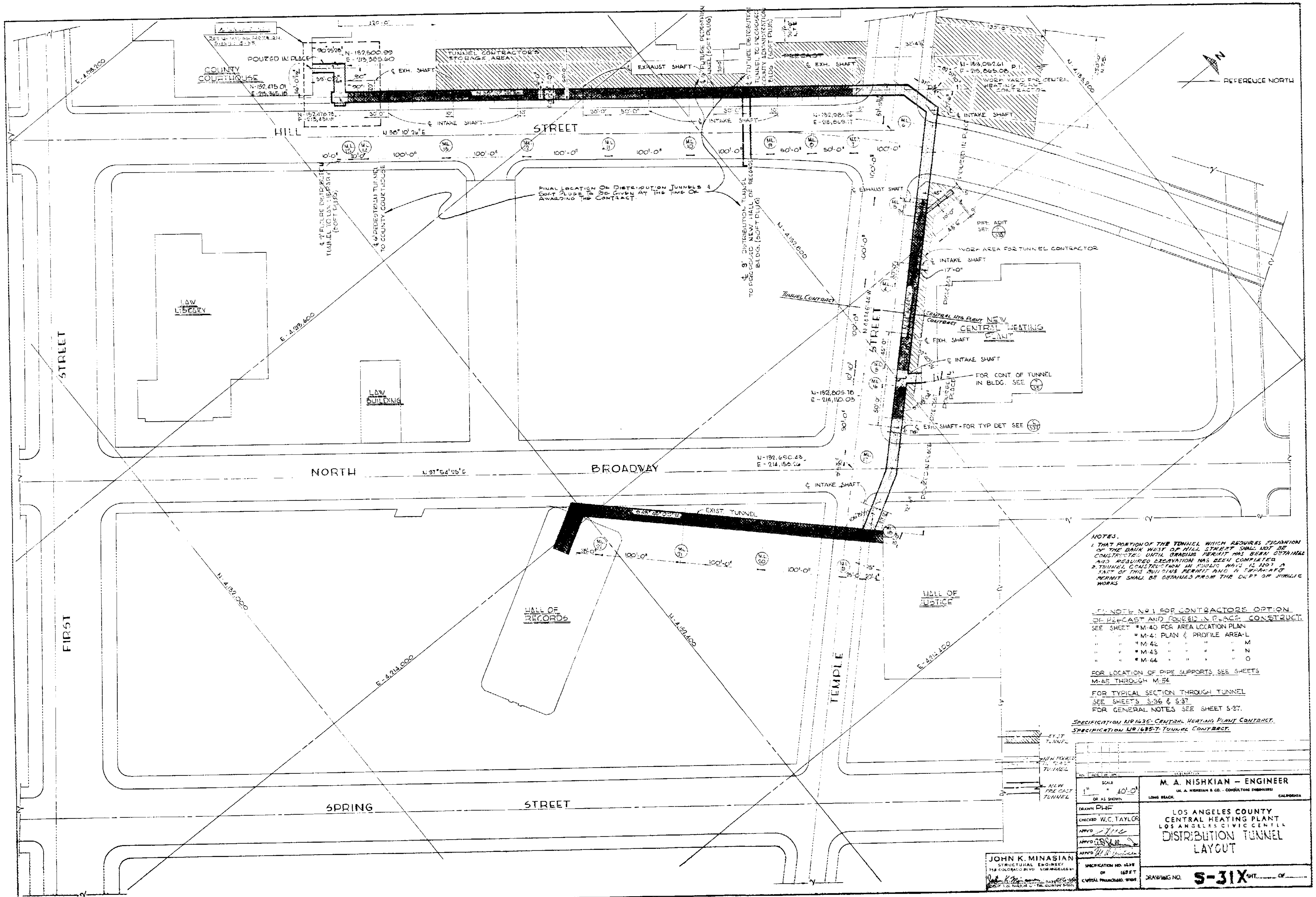
Dear Bill:

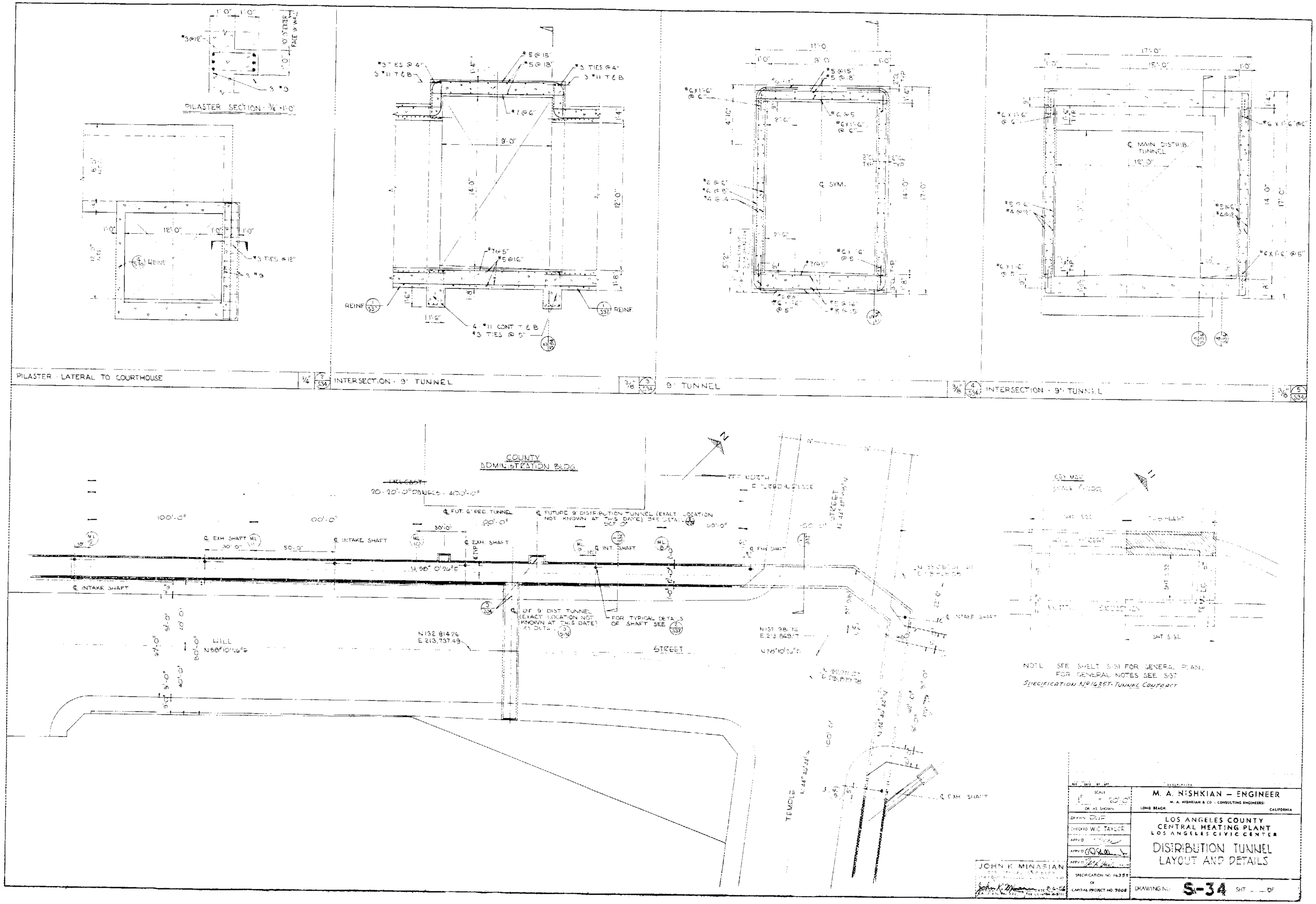
Enclosed are drawings showing the location of Los Angeles County utility tunnels in the Civic Center area. As you can see, the drawings are dated 1956, so do not include some recent revisions. For example, the Hall of Records has been relocated. Also included is a drawing showing the dimensions and utilities located in the tunnel.

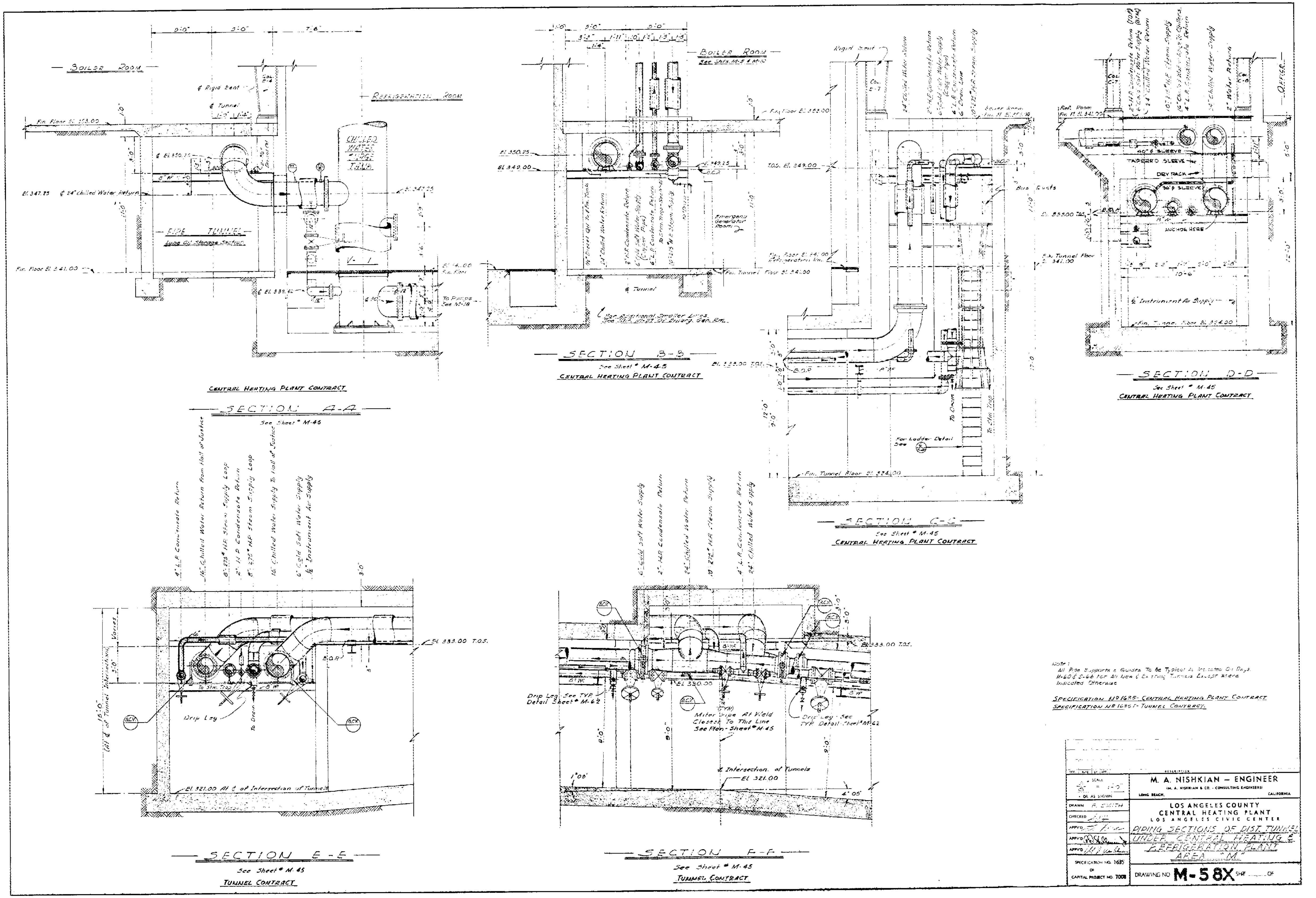
Very truly yours,

Dave

David L. Narver, Jr.


REFERENCE NORTH
COUNTY COURTHOUSE
POURED IN PLACE
TUNNEL CONTRACTOR'S STORAGE AREA
EXHAUST SHAFT
EXH. SHAFT
INTAKE SHAFT
HILL STREET
FINAL LOCATION OF DISTRIBUTION TUNNELS & SOFT PLUGS TO BE GIVEN AT THE TIME OF AWARDING THE CONTRACT
LAW LIBRARY
LAW BUILDING
NEW CENTRAL HEATING PLANT
WORK AREA FOR TUNNEL CONTRACTOR
FOR CONT OF TUNNEL IN BLDG. SEE
TUNNEL CONTRACT
NORTH BROADWAY
EXIST TUNNEL
HALL OF RECORDS
HALL OF JUSTICE
FIRST STREET
TEMPLE STREET
SPRING STREET
NOTES.
1. THAT PORTION OF THE TUNNEL WHICH REQUIRES EXCAVATION OF THE BANK WEST OF HILL STREET SHALL NOT BE CONSTRUCTED UNTIL GRADING PERMIT HAS BEEN OBTAINED AND REQUIRED EXCAVATION HAS BEEN COMPLETED.
2. TUNNEL CONSTRUCTION IN PUBLIC WAYS IS NOT A PART OF THIS BUILDING PERMIT AND A SEPARATE PERMIT SHALL BE OBTAINED FROM THE DEPT OF PUBLIC WORKS
SEE NOTE Nº1 FOR CONTRACTORS OPTION OF PRE-CAST AND POURED IN PLACE CONSTRUCT.
SEE SHEET M-40 FOR AREA LOCATION PLAN
M-41 PLAN & PROFILE AREA-L
M-42 M
M-43 N
M-44 O
FOR LOCATION OF PIPE SUPPORTS SEE SHEETS M-45 THROUGH M-54
FOR TYPICAL SECTION THROUGH TUNNEL SEE SHEETS S-36 & S-37.
FOR GENERAL NOTES SEE SHEET S-27.
SPECIFICATION Nº 1635-CENTRAL HEATING PLANT CONTRACT.
SPECIFICATION Nº 1635-T-TUNNEL CONTRACT.
EXIST TUNNEL
NEW POURED IN PLACE TUNNEL
NEW PRE-CAST TUNNEL
SCALE 1" = 40'-0"
DRAWN PHF
CHECKED W.C. TAYLOR
JOHN K. MINASIAN
STRUCTURAL ENGINEER
M. A. NISHKIAN - ENGINEER
LONG BEACH, CALIFORNIA
LOS ANGELES COUNTY
CENTRAL HEATING PLANT
LOS ANGELES CIVIC CENTER
DISTRIBUTION TUNNEL LAYOUT
DRAWING NO. S-31X


PILASTER SECTION · 3/4"=1'-0"
PILASTER · LATERAL TO COURTHOUSE
INTERSECTION · 9' TUNNEL
9' TUNNEL
INTERSECTION · 9' TUNNEL
COUNTY ADMINISTRATION BLDG.
HILL
STREET
TEMPLE
℄ INTAKE SHAFT
℄ EXH. SHAFT
℄ MAIN DISTRIB. TUNNEL
KEY MAP
NOTE: SEE SHEET S-31 FOR GENERAL PLAN. FOR GENERAL NOTES SEE S-37
SPECIFICATION NO 1635T · TUNNEL CONTRACT
M. A. NISHKIAN – ENGINEER
(M. A. NISHKIAN & CO. · CONSULTING ENGINEERS)
LONG BEACH, CALIFORNIA
SCALE 1" = 20'-0" OR AS SHOWN
DRAWN
CHECKED W.C. TAYLOR
APPV'D
LOS ANGELES COUNTY
CENTRAL HEATING PLANT
LOS ANGELES CIVIC CENTER
DISTRIBUTION TUNNEL
LAYOUT AND DETAILS
JOHN K. MINASIAN
DATE 2-6-56
SPECIFICATION NO 1635T OF CAPITAL PROJECT NO. 7008
DRAWING NO. S-34 SHT OF


SECTION A-A
See Sheet # M-46
CENTRAL HEATING PLANT CONTRACT
SECTION B-B
See Sheet # M-45
CENTRAL HEATING PLANT CONTRACT
SECTION C-C
See Sheet # M-45
CENTRAL HEATING PLANT CONTRACT
SECTION D-D
See Sheet # M-45
CENTRAL HEATING PLANT CONTRACT
SECTION E-E
See Sheet # M-45
TUNNEL CONTRACT
SECTION F-F
See Sheet # M-45
TUNNEL CONTRACT
BOILER ROOM
REFRIGERATION ROOM
PIPE TUNNEL
CHILLED WATER TANK
OFFICE
SPECIFICATION Nº 1635 - CENTRAL HEATING PLANT CONTRACT
SPECIFICATION Nº 1645 - TUNNEL CONTRACT
M. A. NISHKIAN – ENGINEER
(M. A. NISHKIAN & CO. - CONSULTING ENGINEERS)
LONG BEACH, CALIFORNIA
LOS ANGELES COUNTY
CENTRAL HEATING PLANT
LOS ANGELES CIVIC CENTER
PIPING SECTIONS OF DIST. TUNNEL UNDER CENTRAL HEATING & REFRIGERATION PLANT AREA "M"
SCALE OR AS SHOWN
DRAWN
CHECKED
APPV'D
SPECIFICATION NO. 1635
OF
CAPITAL PROJECT NO. 7008
DRAWING NO M-58X SHT ___ OF

JEB 12/2/66

UNIVERSITY OF CALIFORNIA, IRVINE

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO   SANTA BARBARA • SANTA CRUZ

PHYSICAL PLANNING AND CONSTRUCTION   IRVINE, CALIFORNIA 92664

November 28, 1966

Holmes and Narver, Inc.
828 South Figueroa Street
Los Angeles, California 90017

Attention: Mr. David L. Narver, Jr.

Re: UCI Utility Tunnel System

Gentlemen:

In your letter of November 14, 1966, you requested information about the utility tunnel system at UCI.

Attached are the following drawings showing the general plot plan and typical tunnel sections for the existing tunnel system:

Associated Architects Drawing M11.1 Plot Plan
Scott Co. Drawing A 1300 Branch Tunnel Section
Scott Co. Drawing A 1308 Ring and Spoke Tunnel Section
Scott Co. Drawing A 1315 Central Plant Tunnel Section

The following are typical cost estimates for the utility tunnels at ENR 1050:

Branch Tunnel	(6'-6" x 6'-6")	$435.00 lin. ft.
Spoke Tunnel	(6'-6" x 10'-0")	545.00 lin. ft.
Ring Tunnel	(7'-3" x 10'-0")	575.00 lin. ft.
Central Plant Tunnel	(8'-6" x 11'-6")	720.00 lin. ft.

A master plan showing proposed tunnel extensions is not available at this time.

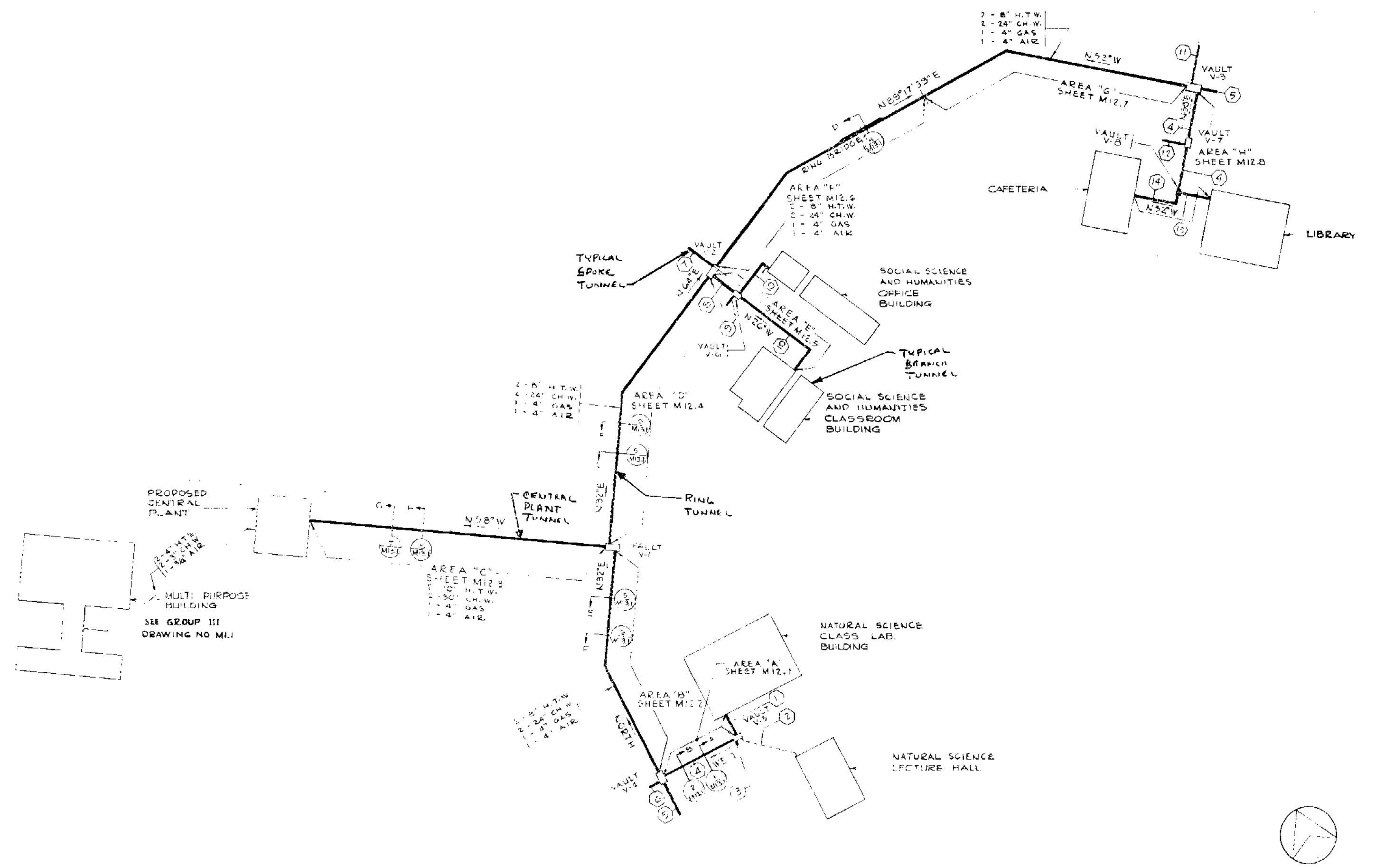
Very truly yours,

T. C. Otto
Sr. Mechanical Engineer

TCO/nn

Enclosure (4)

cc: Dr. James Bresee
Oak Ridge National Laboratory
Oak Ridge, Tennessee



LEGEND
(FOR THIS SHEET ONLY)

DETAIL REFERENCE — DETAIL NUMBER; SHEET NUMBER ON WHICH DETAIL IS SHOWN ON DRAWINGS

(1) INDICATES 2 - 4" H.T.W.
2 - 6" CH.W.
1 - 3" GAS
1 - 2" AIR
2 - 2½" H.H.W. (N.I.C.)
1 - 1" GAS (")
1 - ¾" AIR (")

(2) INDICATES 2 - 3" CH.W. (N.I.C. BEYOND WALL)
2 - 2½" H.H.W. (N.I.C.)
1 - 1" GAS (")
1 - ¾" AIR (")

(3) INDICATES ALTERNATE II-5 WITH
2 - 3" H.T.W.
2 - 10" CH.W.
1 - 2" GAS
1 - 2" AIR

(4) INDICATES 2 - 5" H.T.W.
2 - 12" CH.W.
1 - 4" GAS
1 - 2" AIR

(5) INDICATES ALTERNATE II-3 WITH
2 - 8" H.T.W.
2 - 24" CH.W.
1 - 4" GAS
1 - 4" AIR

(6) INDICATES ALTERNATE II-4 WITH
2 - 6" H.T.W.
2 - 16" CH.W.
1 - 3" GAS
1 - 2" AIR

(7) INDICATES ALTERNATE II-4 WITH
2 - 4" H.T.W.
2 - 14" CH.W.
1 - 3" GAS
1 - 2" AIR

(8) INDICATES 2 - 3" H.T.W.
2 - 8" CH.W.
1 - 2" AIR

(9) INDICATES ALTERNATE II-5 WITH
2 - 2" H.T.W.
2 - 4" CH.W.
1 - 1" AIR

(10) INDICATES 2 - 2" H.T.W.
2 - 4" CH.W.
1 - 1" AIR

(11) INDICATES ALTERNATE II-4 WITH
2 - 4" H.T.W.
2 - 14" CH.W.
1 - 4" GAS
1 - 4" AIR

(12) INDICATES ALTERNATE II-5 WITH
2 - 3" H.T.W.
2 - 6" CH.W.
1 - 3" GAS
1 - 1" AIR

(13) INDICATES 2 - 3" H.T.W.
2 - 6" CH.W.
1 - 1" AIR

(14) INDICATES 2 - 3" H.T.W.
2 - 6" CH.W.
1 - 3" GAS
1 - 1" AIR

TUNNEL EXHAUST FAN SCHEDULE

SYS NO.	SHEET NO.	LOCATION.	C.F.M.	MIN. WHEEL. DIA.	TYPE.	DISCHARGE	S.P. INCHES WATER.	R.P.M.	O.V. F.P.M.	B.H.P.	DRIVE	MOTOR-60 CYCLE.			
												H.P.	R.P.M.	V.	ϕ.
E-1	M-14.2	VAULT V-1.	[illegible]	[illegible]	S.I.S.W.	T.H.D.	[illegible]			[illegible]	V-BELT.		1750	208.	3.
E-2	M-14.2	VAULT V-2.	4000.	18 1/4"	S.I.S.W.	T.H.D.	2"	1495	2085	1.86.	V-BELT.		1750.	208.	3.
E-3	M-14.3	VAULT V-3.	4000.	18 1/4"	S.I.S.W.	T.H.D.	2"	1495	2085	1.66	V-BELT.		1750.	208.	3.
E-4	M-14.1	VAULT V-4.	4000.	18 1/4"	S.I.S.W.	T.H.D.	2"	1495	2085	1.86	V-BELT.		1750.	208.	3.

HILTER

SCHEDULE OF SUMP PUMPS

NO.	LOCATION	No REQ	CAPACITY RANGE		MOTOR				
			GPM @ HEAD	GPM @ HEAD	H P	VOLT	ϕ	CYCLE	RPM
1	VAULT # 1	1	40 @ 33'	10 @ 39'	3/4	208	3	60	1750
2	VAULT # 2	1	40 @ 33'	10 @ 39'	3/4	208	3	[illegible]	1750
3	VAULT # 3	1	40 @ 33'	10 @ 39'	3/4	208	3	60	1750
4	VAULT # 4	1	40 @ 33'	10 @ 39'	3/4	208	3	60	1750
5	VAULT # 5	1	40 @ 33'	10 @ 39'	3/4	208	3	60	1750
6	VAULT # 6	1	40 @ 33'	10 @ 39'	3/4	208	3	[illegible]	1750
7	VAULT # 7	1	40 @ 33'	10 @ 39'	3/4	208	3	[illegible]	[illegible]
* 8	VAULT # 8	1	40 @ 33'	10 @ 39'	3/4	208	3	[illegible]	[illegible]

* IN VAULT NO. 8 PROVIDE 48" DEEP BASIN. ON OTHER VAULTS BASINS ARE 24" X 36" SIZE.

STATE CO. OF CALIFORNIA

PLOT PLAN

REVISIONS	
STRUCTURAL ENGINEERS	BRANDOW & JOHNSTON; J. A. MARTIN & ASSOCIATES
MECHANICAL ENGINEERS	RALPH E. PHILLIPS, INC.
ELECTRICAL ENGINEERS	RALPH E. PHILLIPS, INC.
CIVIL ENGINEERS	MOFFATT & NICHOL; G. SHUIRMAN & ASSOCIATES
DESIGNED	
DRAWN BY	[illegible]
CHECKED BY	L. E.
ARCHITECT	[signature]
ENGINEER	[signature]
UNIVERSITY	[signature]

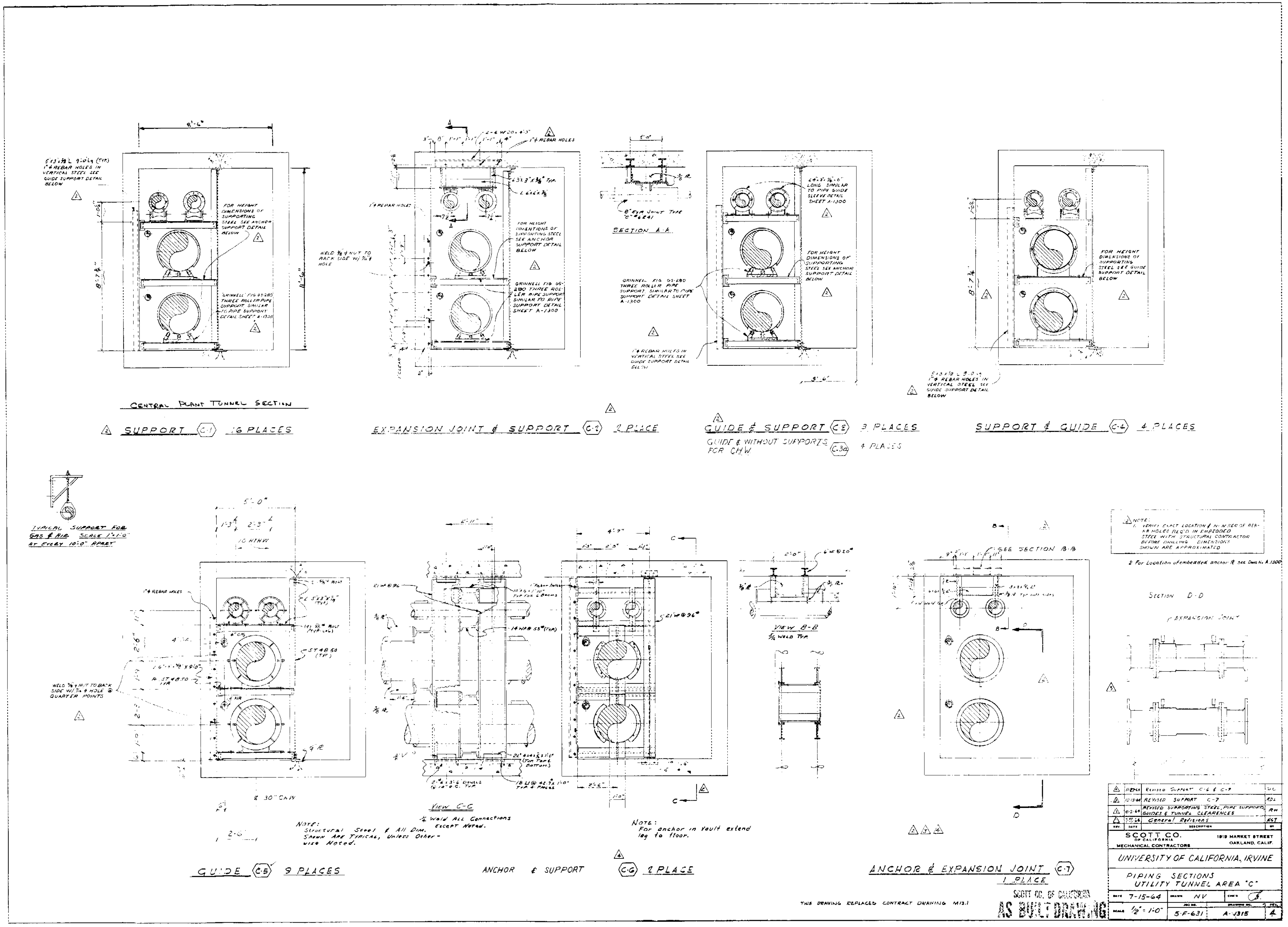
CONSULTING ARCHITECT:
WILLIAM L. PEREIRA & ASSOCIATES
PLANNING & ARCHITECTURE
LOS ANGELES — CORONA DEL MAR

UTILITY AND SITE DEVELOPMENT: GROUP II
UNIVERSITY OF CALIFORNIA IRVINE

ASSOCIATED ARCHITECTS:
WILLIAM L. PEREIRA & ASSOCIATES
A. QUINCY JONES · FREDERICK E. EMMONS & ASSOCIATES
BLUROCK · ELLERBROEK & ASSOCIATES
URBANUS SQUARE · MACARTHUR BOULEVARD AT FORD ROAD
CORONA DEL MAR, CALIFORNIA P. O. BOX 154 714 675-2640

UTIL. TUNNEL
PLOT PLAN

SCALE 1"=100' — I
JOB NO. 909028
DATE APRIL 24, 1964
SHEET NO. M11.1


CENTRAL PLANT TUNNEL SECTION
SUPPORT C-1 16 PLACES
EXPANSION JOINT & SUPPORT C-2 2 PLACE
SECTION A-A
GUIDE & SUPPORT C-3 3 PLACES
GUIDE & WITHOUT SUPPORTS FOR CHW C-3a 4 PLACES
SUPPORT & GUIDE C-4 4 PLACES
TYPICAL SUPPORT FOR GAS & AIR SCALE 1"=1'-0" AT EVERY 10'-0" APART
VIEW B-B
VIEW C-C
SECTION D-D
GUIDE C-5 9 PLACES
ANCHOR & SUPPORT C-6 2 PLACE
ANCHOR & EXPANSION JOINT C-7 1 PLACE
NOTE: Structural Steel & All Dim. Shown Are Typical, Unless Otherwise Noted.
NOTE: For anchor in vault extend leg to floor.
THIS DRAWING REPLACES CONTRACT DRAWING M13.1
SCOTT CO. OF CALIFORNIA
AS BUILT DRAWING
11-27-64 Revised Support C-6 & C-7 DC
10-13-64 REVISED SUPPORT C-7 RDL
8-2-64 REVISED SUPPORTING STEEL, PIPE SUPPORTS, GUIDES & TUNNEL CLEARENCES RH
7-15-64 General Revisions KST
REV. DATE DESCRIPTION BY
SCOTT CO. OF CALIFORNIA MECHANICAL CONTRACTORS
1919 MARKET STREET OAKLAND, CALIF.
UNIVERSITY OF CALIFORNIA, IRVINE
PIPING SECTIONS UTILITY TUNNEL AREA "C"
DATE 7-15-64 DRAWN NV
SCALE 1/2" = 1'-0" JOB NO. 5-F-631 DRAWING NO. A-1315 REV. 4

APPENDIX C -SURVEY OF EXPERIENCE OF ACCOMMODATING FUEL GAS IN TUNNELS

Telephone discussions were held with representatives of the American Insurance Association, National Fire Protection Association, American Gas Association, and the Edison Electric Institute, concerning the advisability of installing fuel gas lines in utility tunnels containing power lines and other utilities. These discussions are summarized below:

1. American Insurance Association - Their technical director, Mr. Arthur Spiegalman, was deeply concerned about putting fuel-gas lines in tunnels. He suggested we contact the New York Fire Rating Bureau to get their reaction as to the effect on insurance rates, etc. He also mentioned the possible use of a vented jacket around the gas pipe to make leak detection possible without allowing flammable vapors to escape into the tunnel.

2. National Fire Protection Association - Mr. W. L. Walls emphasized the number of explosions caused by gas leaks from underground gas lines. Many such incidents are summarized in the National Fire Protection Association Quarterly.[14] It was his first impression that tunnels would be as safe or safer than buried gas lines. It appeared to him that tunnels offered a natural solution to the serious problem of undetected gas leaks (the so-called "sub-structure problem") since tunnels would make leaks easily detectable and the tunnels would offer protection from damage during digging operations (or obviate the need to excavate). The problem is so serious that Massachusetts has a law requiring the gas company to be notified before digging operations commence. He also pointed out that gas from underground leaks often finds its way into other utility lines and he did not think it would be much worse in tunnels. Mr. Walls volunteered to check their records and send any information they had on tunnel explosions. A copy of the memorandum received from Mr. Walls is included in Appendix C.

With regard to electrical systems, he pointed out the potential hazard of grouped power cables and the serious fires that have resulted[15]. The problems associated with fires in underground spaces has recently been discussed by Bond.[16]

3. American Gas Association - Mr. Stan Setchell knew of no instances where distribution gas lines were run in utility tunnels with other utilities; however, there are numerous instances where such lines are run in tunnels under rivers or other geographical features. One of the best known examples is the Astoria Tunnel built in 1915[9] to carry two, 72-inch gas mains under the East River. These mains were removed in 1963 to clear the tunnels for electric cables[10]. Other examples are the Gas Main Tunnel under the Schuykill River[17], the pipe tunnel under the Gowanis Canal[18], and the North Illinois Gas Company tunnel under the Chicago Sanitary and Ship Canal[19].

Parliamentary approval was given to place two, 18-inch gas mains in the new Dartford Tunnel under the Thames River either in the fresh air ducts under the roadbed or overhead in the soffit of the arch as shown in the attached drawing. An 18-inch gas line has also been installed in the Mersey Tunnel and two, 12-inch gas lines were installed in the pedestrian tunnel under Maas River in Holland.

Mr. Setchell was concerned about the advisability of placing the gas lines in a distribution tunnel serving buildings and would advise a conservative approach to the design and operation of such a system.

4. Edison Electric Institute - Mr. C. K. Poarch thought there were numerous situations where multiple services had been jointly installed for river and bridge crossings although no specific references were cited.

NATIONAL FIRE PROTECTION ASSOCIATION
INTERNATIONAL
EXECUTIVE OFFICE: 60 BATTERYMARCH STREET, BOSTON, MASSACHUSETTS, U. S. A. 02110
Organized 1896 • Incorporated 1930 *Telephone 482-8755 Direct Dial Prefix: 617*

September 13, 1966

Mr. James T. Blackmon, Jr.
Union Carbide Corp.
Nuclear Division
Bldg. 9733-2
Oak Ridge, Tenn. 37831

Dear Pete:

This refers to our telephone conversation about utility tunnels in urban renewal projects.

The enclosed copy of NFPA No. 328 should be useful.

Our Fire Record Department has augmented this with the memo dated September 12, 1966.

After studying this data and the article in the January 1958 "Quarterly", I think you can build a safety case in favor of the tunnel although, overall, it probably boils down to what is the lesser of two evils.

I would be interested in seeing what you come up with and would be happy to offer any comments.

Best regards.

Sincerely,

W. L. Walls
Gases Field Service

WLW:amk
enc.

MEMORANDUM

To: W. L. Walls
From: Daniel Pingree
Date: September 12, 1966

On: Utility Tunnel Explosions Reported to NFPA

In recent years there have been a number of utility tunnel explosions or flash fires reported to us, and some slow fires in electric cable insulation. Unless the latter resulted in a subsequent smoke explosion, they are not generally included here, except for two instances under "B".

The incidents are divided into four groups: A. Gas Explosions; B. Incidents involving Construction or Repair; C. Electric Insulation or Transformer "Explosions;" and D. Gasoline Vapor Explosions. Under the last mentioned is included the famous Cleveland sewer explosion of 1953. While there was no "tunnel" here, there might well have been trouble if there had been, in view of the abandoned natural gas wells in the area.

A. Tunnel Explosions - Gas

March 23, 1960, Indianapolis, Ind. Gas main explosion trapped six men in deep underground tunnel. Three were killed, while the three injured were lifted up a 35-foot shaft. No data on cause of explosion.
Dec. 17, 1959, Long Beach, Calif. While a 30-inch water main was being installed by a tunneling process, gas of some kind leaked into the opening. The construction company thought the gas might be methane. At two different locations within the pipe, where men were working cleaning up debris, explosions occurred, killing two men at each location. Fans were used to clear the pipe before victims were removed.

B. Water or Sewer Tunnels Under Construction or Repair

Apr. 27, 1961, Northboro, Mass. Dynamite, possibly set off during a thunderstorm, exploded without warning and killed one worker, while injuring others, in this tunnel.
Mar. 17, 1960, North York, Ont. Sparks from a welding operation in the compressed air atmosphere of a watermain tunnel being constructed under the Don River ignited a rubber hose. The fire then spread to rubber covered cables. In the confusion that followed, five inexperienced workmen were killed by carbon monoxide poisoning.
Aug. 23, 1957, Pittsburgh, Pa. A short circuit caused a fire in an electric locomotive in a sewer tunnel under construction. Fifteen men were trapped behind the locomotive until masked firemen could arrive and extinguish the fire with hand apparatus. Ventilation was maintained during this three hour period through an air shaft, and none of the men was injured. No explosion occurred.

C. Transformer Vaults and Cable Tunnels or Ductwork

Jan. 3, 1962, New Britain, Conn. Short occurred in conduit in a tunnel or duct. Fire produced smoke which exploded, causing manhole covers to pop off. Men crawled in and made repairs. Power restored in three hours. F. D. used smoke ejectors to clear the space.

Sept. 11, 1964, Camden, N. J. A transformer in an under sidewalk vault "exploded" and ignited neoprene insulation of grouped cables. The fire traveled in the cable tunnel, causing two manhole covers further along the street to pop open. After power was cut off, the fire was quickly extinguished with dry chemical.
Feb. 13, 1964, El Paso, Tex. Malfunction at a switch caused an explosion or flash fire in a street transformer vault. Four men were working in the vault at the time, of whom one died. Fire was extinguished by cutting off power.
June 29, 1960, Cleveland O. Fault developed in an underground circuit, and insulation smoldered until hot gases came in contact with air drawn through manholes. There were then five smoke explosions, flipping off manhole covers and breaking glass.
Jan. 30, 1961, New York This and other grouped cable fires in tunnels are described in the soon to be published fire hazard study on grouped electric cables. However, there were no explosions in these cases.

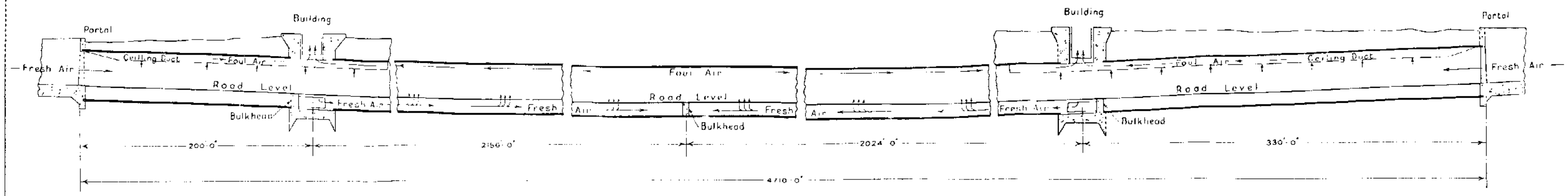
D. Gasoline Seepage into Tunnels

Aug. 22, 1962, Philadelphia, Pa. Workmen were digging a tunnel about 40 feet below grade level for an interceptor sewer. Several explosions occurred, killing four, and fire followed. Firemen attached a nozzle to a ladder and lowered it into the shaft. The fire was then extinguished and smoke ejectors were used to force out vapors. There were bulk gasoline plants along the tunnel route, and gasoline is assumed to have accumulated overnight from one of these.
Oct. 27, 1953, Detroit, Mich. An explosion in underground ductwork for public utility power lines were traced to gasoline that had entered the ducts from three carroded underground gasoline tanks. The ensuing fire burned several hundred feet of cable. To assure permanent extinguishment, it was necessary to remove all gasoline from the tanks and dig up several yards of sidewalk to direct the vapors away from the ductwork.
Sept. 10, 1953, Cleveland, O. This explosion occurred in a sewer rather than a tunnel, but if a tunnel had been there, this also would have been affected. One woman was killed, 64 persons injured, automobiles crushed, water and gas mains broken, reinforced concrete road upheaved, and over one mile of sewer line destroyed. Either a flammable liquid had been discharged into the sewer, or there had been seepage from abandoned natural gas wells in the area. Loss was $5,000,000.

DARTFORD TUNNEL

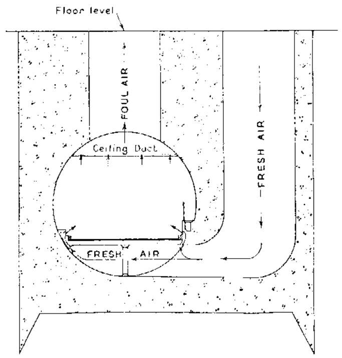
COUNTY OF ESSEX

COUNTY OF KENT

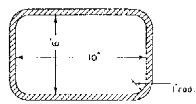


LONGITUDINAL SECTION

Building, and intake and exhaust shafts to be arranged to suit fan requirements.

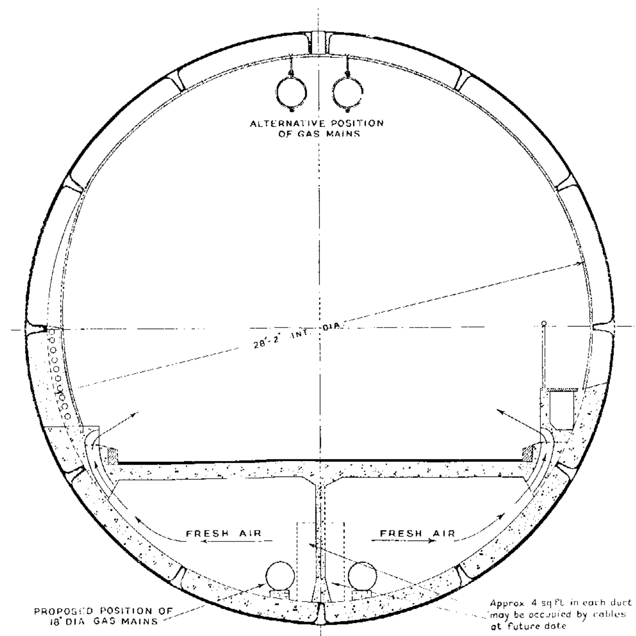


CROSS SECTION THROUGH VENTILATION SHAFTS



CROSS SECTION OF AIR INLET

AREA ·408 SQ. FT.



CROSS SECTION THROUGH TUNNEL

SCALE 3/8" = 1'-0"

DRG. Nº 2837

APPENDIX D - INFORMATION FROM OTHER SOURCES

1. National Academy of Sciences - The problems and practices associated with installing underground heat distribution systems excluding walk-in tunnels has been extensively studied by a Federal Construction Council Task Group. Their work is summarized in references 20 - 24. Mr. Paul R. Achenback of the Bureau of Standards, who has served with the Task Group from the beginning, explained that walk-in tunnels were excluded from their work because the principle difficulties were with direct-burial systems. He also told us that if they hadn't been pressed for funds they would have preferred tunnels at the new site for the Bureau. Mr. W. H. Stevenson of GSA, also a member of the Task Group, feels that tunnels are too expensive except in special circumstances and they had not been able to justify them lately.

2. National District Heating Association - References describing the Beacon East Tunnel, installed by the Detroit Edison Company to carry a 20 inch steam line under an expressway(25), and of the panel discussion(8) entitled "Tunnels versus Conduits" in the proceeding of the Association were provided by the secretary.

3. Portland Cement Association - Reprints of articles concerning the use of precast sections for utility tunnels were provided. (See References 3 - 6.)

4. Armco Steel Corporation - Telephone discussions with Mr. Booth and Mr. Carlson indicate that steel preformed sections are extensively used for utility tunnels for process lines, to run utilities under railroads and highways, and for pedestrian tunnels between buildings.

5. Naval Civil Engineering Laboratory - The utilidors used at the Greenland stations have been described by Coffin(26).

6. Kansas State University - Professor Emil Fischer, Dean of the College of Architecture, knew of no information on the underground utility tunnel concept, however, he suggested we contact the American Society of Planning Offices, The Urban Land Institute and HUD. (See attached letter.)

7. American Society of Planning Offices – A bibliography of published information on underground utilities was supplied as given in the attached letter.

Kansas State University

Manhattan, Kansas 66502

College of Architecture and Design
Seaton Hall

September 27, 1966

Mr. W. J. Boegly
Health and Physics Division
Argonne National Labs
P.O. Box X
Oak Ridge, Tennessee

Dear Mr. Boegly:

Dean Fischer, College of Architecture and Design, has asked me to reply to your inquiry to him concerning underground utilities. As I understand your inquiry, you are interested in information and case studies relating to underground utilities with an access tunnel.

There are a number of communities in the United States that have investigated and implemented underground utilities systems of varying extent and types. I am not personally aware of systems that have utilized access tunnels, with the exception of the downtown centers of major cities, of course. I would suggest that you contact the three listed agencies for comparative data on this topic.

1. The American Society of Planning Officials
   1313 East Sixtieth Street
   Chicago, Illinois 60637

2. The Urban Land Institute
   1200 18th Street, N.W.
   Washington 6, D. C.

3. Department of Housing and Urban Development
   Washington, D.C. 20410

If we can be of any further assistance, please write.

Sincerely,

Vernon P. Deines

Vernon P. Deines
Associate Professor and Director
Regional and Community Planning

VPD:gl
cc: Dean E. C. Fischer

research • consulting services • publications • conferences

AMERICAN ASPO SOCIETY OF PLANNING OFFICIALS

1313 E. Sixtieth St. • Chicago, Illinois 60637 • Area Code 312, 324-3400

October 17, 1966

Mr. W. L. Griffith
Union Carbide Corporation
Building 9704-2
P.O. Box Y
Oak Ridge, Tennessee 37831

Dear Mr. Griffith:

We have done some research in our files in response to your telephone inquiry and have come up with the following sources of information on underground utilities:

Guide for Underground Design and Construction (of electric utilities), Association of Municipal Electric Utilities of Toronto, 620 University Avenue, Toronto 2, Ontario, June 1959.

Underground Power Transmission, a report to the Federal Power Commission by the Commission's Advisory Committee on Underground Transmission, April 1966.

Program for Advancing Underground Electric Power Transmission Technology, U.S. Department of the Interior, Chief Engineering Advisor, Office of the Secretary, Room 6619, Department of the Interior, Washington, D.C. 20240, 1966.

Underground Cables: An Annotated Bibliography 1960-1965, Suzanne Appelt and Rod Moorman, U.S. Bonneville Power Administration, Portland, Oregon 97208, July 1966.

Substructure Control, E. F. Gabrielson, City Engineer, San Diego, Calif., August 1960.

In addition, you might wish to contact the following organizations for further assistance:

Canadian Electrical Association, Inc.
345 Victoria
Westmount 6, Quebec

American Society of Planning Officials

Federal Housing Administration
Washington, D.C.

Commonwealth Edison Company
72 West Adams Street
Chicago, Illinois

The City of Oakland, California in which a builder has developed a "systemized" method for installing all utilities under the sidewalks.

I hope these references are helpful to you. When you have completed your research, we would very much appreciate your sending us a copy of the report for our files.

Sincerely,

Michael J. Meshenberg

Michael J. Meshenberg
Senior Planner

MJM/ev

REFERENCES

1. Municipal Conduit System of the City of Baltimore, Electrical World, pp 13 - 16 (Jan. 1908).

2. J. C. Nepveu, The Municipal Conduit System in Montreal, Presented at the C.E.A. Eastern Zone Winter Meeting, Niagara Falls, Ontario (Jan. 22 to 25, 1962).

3. Elliptical Pipe Used for Utility Tunnel, Concrete Pipe News, pp 81 - 83, (July 1956).

4. Concrete Pipe for Utility Tunnels, Concrete Pipe News, pp 28 - 30, (March 1956).

5. H. R. Sweet, Precast Concrete Culverts, Western Construction (February 1955).

6. Utility Chooses Pre-Cast Cable Ducts for Substations, Power Engineering, pp 62 - 63, (December 1962).

7. Lindsay, A Canadian High Temperature Water Performance Story, Canadian Power Engineer, pp 16 - 23 (December 1963).

8. G. K. Saurwein, et al., Tunnels Versus Conduits, National District Heating Association Proceedings, pp 105 - 108, (1956).

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